THE
ENGINEERING MAGAZINE
THE WORLD IS ITS FIELD

VOL. XXXVIII. DECEMBER, 1909. No. 3.

THE STATISTICAL POSITION AND FUTURE OF COPPER.

By James Douglas, LL.D.

Dr. Douglas's careful exposition of the outlook in the copper trade, prepared at the special instance of THE ENGINEERING MAGAZINE, is presented with even more than ordinary satisfaction because of the high authority and judicial temper of the author, and the unusual interest now centered in this great mining industry. It stands next to steel in intrinsic importance and as a "barometer" of conditions in other engineering activities. Dr. Douglas does not concern himself in the least with the "politics" of copper, so to speak—the influences working for consolidations or mergers now discussed in financial circles. He deals only with natural economic conditions affecting the production of copper, and the phenomena by which the condition of the industry may be read. He considers influences that no artificial institutions can permanently alter or evade. And in these natural conditions alone Dr. Douglas sees a certainty of great future prosperity to copper producers, because of great prosperity in the industries at large.—THE EDITORS.

IN an article on the copper situation which appeared in this Magazine in October, 1907, I pointed out that there has been for the last ten years an average consumption of 84 tons of iron to 1 ton of copper. If to the table then published there be added the statistics of the production and consumption for 1907 and 1908, we can study the effect of the disproportionate production of the two metals during the period of depression. The enlarged table appears on pages 326 and 327.

During 1905, when we were beginning to feel the stimulus of the boom, the production of pig iron in the United States rose rapidly from 16½ million to 23 million tons; it remained stable during the two following years at between 25 million and 26 million tons, but responded to the reduced demand in 1907-1908 by falling to about 16 million tons. This represented a percentage decline of 38 per cent in one year. The production kept pace with consumption, as it was evi-

PRODUCTION AND CONSUMPTION OF PIG IRON AND PIG COPPER—1897-1908.

Year	Pig Iron Produced in United States		Pig Iron Consumed in United States	
	Long Tons	Per Cent of Increase	Long Tons	Per Cent of Increase
1897	9,652,680	11.94	9,381,914	13.36
1898	11,773,934	20.97	12,005,674	27.96
1899	13,620,703	15.67	13,779,442	14.69
1900	13,789,242	1.23	13,177,409	*4.45
1901	15,878,354	15.29	16,232,446	23.18
1902	17,821,307	12.23	18,436,870	13.58
1903	18,009,252	1.61	18,039,909	*2.15
1904	16,497,003	*8.39	16,679,555	*7.54
1905	23,010,625	39.48	23,155,624	38.82
1906	25,307,191	9.98	25,603,202	1.06
1907	25,781,361	1.87	26,196,957	2.32
1908	15,936,018	*38.19	15,981,524	*38.99
	207,077,670	6.98	208,670,526	6.82

*Decrease.

dently not the policy of either the Steel Corporation or the Independents to enter the markets of the world. If the figures be correct, 1907 consumed a slight surplus left over from 1906. But production and consumption in 1908 almost exactly balanced.

During the same period, 1905, the production of copper was 390,000 tons, or on increase of only 7.04 per cent over 1904, and yet in the face of a rising market, the copper companies were able to produce in 1906 only 409,000 tons. During the closing months of the following year the Anaconda Company closed down and most of the sulphide companies reduced their production, bringing down the output from 409,000 tons in 1906 to 392,000 tons for 1907, or 17,000 tons under 1906. But, despite the continued trade depression, all the copper mines resumed active work in 1908, and the production in that year exceeded that of 1907 by 31,000 tons, though the domestic consumption of the United States declined 22,000 tons. This occurred in the face of a decline in the production of pig iron of 38 per cent, and of a similar decline in the domestic consumption of iron and steel, for we assume that all was consumed which was made.

The balance was thus temporarily disturbed, and the disturbance became more marked during the first half of the present year, when the American production of iron was only 7,046,806 tons, and the domestic production of copper was admittedly largely in excess of that of 1908. This condition necessarily involved an accumulation of the red metal, which accounted for the growing surplus of copper stocks.

PRODUCTION AND CONSUMPTION OF PIG IRON AND PIG COPPER—1897-1908.

Pig Copper Produced in United States		Pig Copper Consumed in United States		Long Tons Pig Iron Consumed to 1 Long Ton Copper
Long Tons	Per Cent of Increase	Long Tons	Per Cent of Increase	
221,958	6.32	122,500	20.	77
236,109	6.38	122,383	* .10	98
255,272	8.12	174,822	42.85	79
263,178	3.09	155,169	*11.24	85
266,716	1.34	196,837	26.85	82
284,284	6.59	209,241	6.30	88
316,239	11.24	221,222	5.73	82
365,051	15.43	208,082	*5.94	80
390,733	7.04	273,652	31.51	85
409,652	4.84	298,472	9.07	89
392,519	*4.18	240,098	*19.55	109
423,302	7.84	218,087	*9.17	73
3,825,013	6.17	2,440,565	8.03	85

*Decrease.

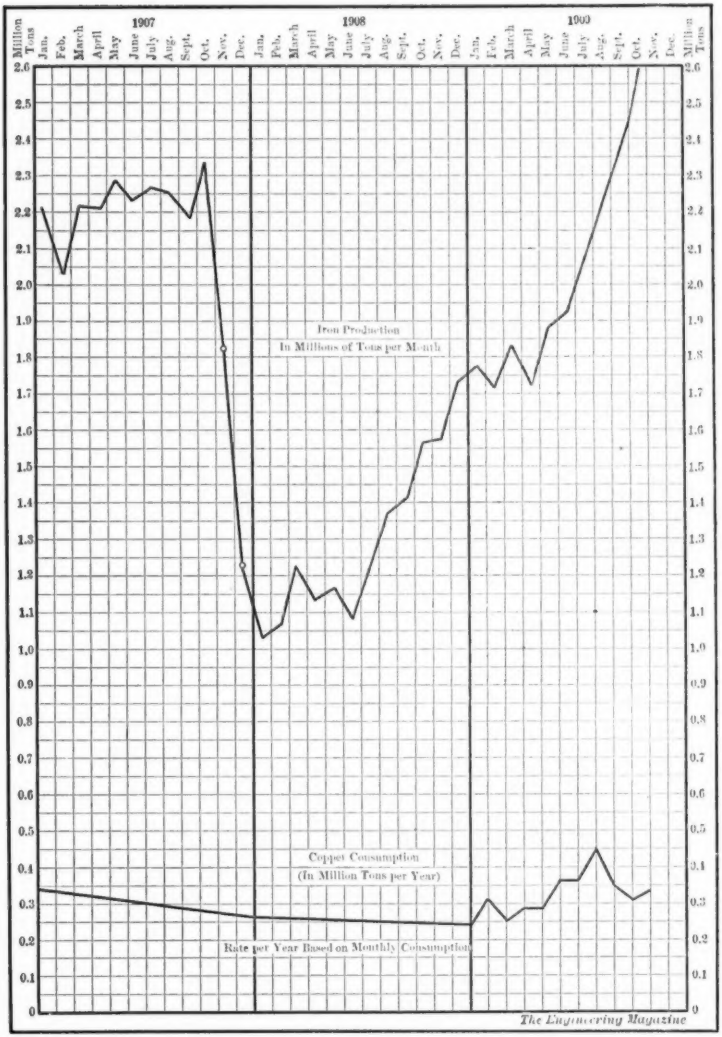
If we take the consumption of the world instead of the calculated consumption of the United States, and assume that the production of the world and the consumption of the world of both metals are equal, the results approximately correspond over a period of ten years with the results deduced from American production and consumption, as shown by the following table:

WORLD'S PRODUCTION OF PIG IRON AND PIG COPPER.

	Pig Iron Produced		Pig Copper Produced		Tons Pig Iron Produced to 1 Ton Pig Copper
	Long Tons	Per Cent Increase	Long Tons	Per Cent Increase	
1900	38,973,644		483,668		81
1901	40,303,525	3.41	521,140	7.74	77
1902	43,641,808	8.28	534,031	2.47	82
1903	46,369,165	6.25	620,624	16.21	75
1904	45,341,438	*2.21	682,284	9.93	66
1905	53,200,524	14.33	687,885	.82	77
1906	58,141,267	9.29	704,182	2.37	83
1907	59,721,053	2.72	711,234	1.01	84
1908	47,508,692	*20.44	750,067	5.46	63
	433,201,116	2.70	5,695,115	5.75	76

*Decrease.

The average ratio agrees, but there are startling periodical variations. Through one of those periodical variations we are passing. If instead of a consumption in the United States of 84 tons of iron to one ton of copper, only 78 tons of iron were consumed in 1908 to one ton



CURVES SHOWING COMPARISON BETWEEN PRODUCTION OF COKE AND ANTHRACITE PIG IRON AND THE CONSUMPTION OF COPPER IN THE UNITED STATES, 1907, 1908 AND 1909.

The upper curve showing pig-iron production is taken from the *Iron Age*, and shows millions of tons per month. The lower curve added shows copper consumption in millions of tons per year averaged on the monthly rate of consumption.

of copper, while copper up to the full measure of one to 85 was being turned out, more copper was being made than there was a market for. The monthly statistics prove that to have been the case.

But during the third quarter of the present year the tide has turned and is running in the opposite direction. While the output of copper has continued large and the consumption slight, the demands on the iron and steel trade for actual consumption have become rapidly so great as to outstrip in great measure the efforts of the copper producers, both old and new, to keep pace with them. We have taken the liberty of adding to a diagram from the *Iron Age*, of the Coke and Anthracite Pig-Iron Production for the United States in 1907, 1908 and 1909, a curve, representing the current of copper consumption in the country during the corresponding period.

Assuming that the average proportion of the iron production and the copper consumption is correct and that it will be maintained, if iron production and copper consumption should continue for any length of time to proceed at the present rate, the stock of copper on hand will rapidly disappear and the balance be restored. It may, however, take some time to adjust the disturbed equilibrium.

BOILER EFFICIENCIES FOR VARIOUS COALS.

By T. F. J. Maguire.

Mr. Maguire's article is one of a short series in which he reduces some of the fundamental problems of the power plant to concrete and exact expression. A preceding paper discussed grate areas and a following one will take up stack proportions.—THE EDITORS.

BOILERS, especially of the water-tube type, are in many cases purchased upon certain guarantees as to their economical operation. These guarantees of economy are almost invariably based upon the so-called "boiler efficiency" and "efficiency of boiler and furnace." Boiler efficiency is defined as the ratio of the heat absorbed by the contents of the boiler per pound of combustible, to the heating value of one pound of combustible. The combined efficiency of boiler and furnace is defined as the ratio of the heat absorbed per pound of coal to the heating value of one pound of coal. In order to calculate these efficiencies for any given test, the following quantities must be known:—the average number of pounds of water evaporated per pound of coal, the ash obtained from the test, the heat value of the coal, and the percentage of moisture, ash, and combustible in the coal. Let w represent the number of pounds of water evaporated from and at 212 degrees F. per pound of coal as fired, a′ represent the percentage of ash and refuse obtained in test in terms of the coal fired, H_c represent the heat value of the coal per pound of combustible, m represent the percentage of moisture in the coal, and a the percentage of ash in the coal; then the boiler efficiency will be expressed by the formula

$$\frac{96{,}570\ w}{H_c\ (100-m-a')}$$

and boiler and furnace efficiency by the formula

$$\frac{96{,}570\ w}{H_c\ (100-m-a)}$$

A "proximate" analysis is made of a sample of the coal taken during the test and the percentages of moisture, ash and combustible matter are ascertained, thus giving the quantities designated as "m" and "a" in the above formulæ. The heat value of the coal is obtained

by testing a suitable sample in a calorimeter, and the calorific value of the fuel per pound of combustible (H_c) is readily ascertained in British thermal units. The ash and refuse obtained in the test, expressed in percentage of total coal fired, (a''), is readily obtained from the total coal and total ash.

It will be noticed by comparing the two formulæ above that the "boiler efficiency" and "boiler and furnace efficiency" will be the same in value when the ash and refuse obtained in the test equals the ash obtained from analysis, or when $a=a'$. With solid fuels this will never be the case, owing to the fact that some unconsumed coal is bound to fall through the grate. In fact, the difference between a and a' gives a good measure of the grate or stoker efficiency. With liquid or gaseous fuels the two efficiencies are identical, owing to the absence of ash, or a and a' are both equal to zero. The efficiencies are invariably based upon test results with the boiler developing practically its rated capacity and under first-class conditions of operation.

The operating economy of a boiler depends upon the design of the boiler and its furnace and the relative arrangement of the two. The design of the boiler is practically independent of the type of fuel used, and so far as economy is concerned, the features to look out for are to secure sufficient heating surface and to arrange this surface so as to compel the gases of combustion to pass over as much of it as possible. Incidentally the radiation losses from the setting walls and exposed parts of the boiler should be kept as small as possible, and the arrangement of boiler parts should be such as to secure practically dry steam within the capacity limits for which the boiler is designed. The furnace must receive every attention if good economy is to be expected, and its design is influenced to a considerable degree by the quality and class of fuel that is to be used. For solid fuels, the grate area depends not only upon the rated capacity of the boiler, but also upon the maximum output at which the boiler will be driven for any considerable time. The rate of combustion, or the number of pounds of fuel burned per square foot of grate per hour, varies greatly for differert coals and must be closely considered if economical results are to be obtained. The intensity of draft to be used is to a certain extent dependent upon the grate area and must receive very careful consideration. The losses due to an imperfect furnace are fuel loss through the grate, incomplete fuel combustion, and excessive air supply.

The relative arrangement of boiler and furnace should be such as to procure a path of sufficient length for the hot gases from the furnace, to enable the gases to be completely burned before impinging on the heating surface; otherwise the combustion will be incomplete.

It is almost needless to state that however well a boiler and its furnace may be designed for a given set of conditions, the operating economy will be comparatively poor unless the plant is controlled by intelligent firemen, and this applies as well to plants using automatic stokers and all possible improved devices as to simple hand-fired plants. A good fireman is the most economical "piece of apparatus" yet devised for a boiler room.

The following efficiencies and evaporative capabilities are believed to be safe conservative figures for the various coals considered; they are based upon the assumption that the furnace and draft conditions are consistent with the kind of coal used, that the boiler is of good design and is properly set with respect to the furnace, that the equipment is in good condition and is intelligently handled. The figures are further based upon the assumption that the equipment is operated at about rating, and not over 10 per cent above or below rating. The evaporation capabilities are very often used in place of efficiencies, the evaporation from and at 212 degrees F. per pound of combustible corresponding to the boiler efficiency, and the evaporation from and at 212 degrees F. per pound of dry coal corresponding to the efficiency of boiler and furnace.

Eastern Bituminous and Semi-Bituminous Coals of 13,000 B.T.U. per Pound of Dry Coal.—These coals may be assumed to have a moisture content of about 4 per cent and an ash of about 10 per cent, giving a calorific value of 14,500 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 12 per cent of the coal fired. A boiler efficiency of 72 per cent is the best that should be assumed for these coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w=9.08 pounds, and the boiler and furnace efficiency is equal to 70.3 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 9.46 pounds, and the evaporation from and at 212 degrees F. per pound of combustible is 10.81 pounds.

For these coals then, the following would be consistent and reliable guarantees:—a boiler efficiency of 72 per cent; a boiler and furnace efficiency of 70 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 9.5 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 10.8 pounds.

Eastern Bituminous and Semi-Bituminous Coals of 13,500 B. T. U. per Pound of Dry Coal.—These coals may be assumed to have a moisture content of 2 per cent and an ash of 7 per cent, giving a calorific value of 14,540 B.t.u. per pound of combustible. The ash

from a test for efficiency may be taken equal to 9 per cent of the coal fired. A boiler efficiency of 73 per cent is the best that should be assumed for these coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w=9.78 pounds, and the boiler and furnace efficiency is equal to 71.4 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 9.98 pounds, and the evaporation from and at 212 degrees F. per pound of combustible is 10.99 pounds.

For these coals then, the following would be consistent and reliable guarantees:—a boiler efficiency of 73 per cent; a boiler and furnace efficiency of 71 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 9.9 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 11.0 pounds.

WESTERN BITUMINOUS COALS OF 12,000 B.T.U. PER POUND OF DRY COAL.—These coals may be assumed to have a moisture content of 8 per cent and an ash of 15 per cent, giving a calorific value of 14,300 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 20 per cent of the coal fired. A boiler efficiency of 65 per cent is the best that should be assumed for the coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w=6.93 pounds, and the boiler and furnace efficiency is equal to 60.8 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 7.53 pounds, and the evaporation from an at 212 degrees F. per pound of combustible is 9.63 pounds.

For these coals then the following would be consistent and reliable guarantees:—a boiler efficiency of 65 per cent; a boiler and furnace efficiency of 61 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 7.5 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 9.6 pounds.

WESTERN BITUMINOUS COALS OF 11,000 B.T.U. PER POUND OF DRY COAL.—These coals may be assumed to have a moisture content of 12 per cent, and an ash of 20 per cent, giving a calorific value of 14,200 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 23 per cent of the coal fired. A boiler efficiency of 62 per cent is the best that should be assumed for these coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w=5.93 pounds, and the boiler and furnace efficiency is equal to 59.3 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 6.74 pounds and the evaporation from and at 212 degrees F. per pound of combustible is 9.12 pounds.

For these coals then the following would be consistent and reliable guarantees:—a boiler efficiency of 62 per cent; a boiler and furnace efficiency of 59 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 6.7 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 9.1 pounds.

ANTHRACITE BUCKWHEAT No. 2 OF 12,000 B.T.U. PER POUND OF DRY COAL.—These coals may be assumed to have a moisture content of 5 per cent and an ash of 16 per cent, giving a calorific value of 14,400 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 20 per cent of the coal fired. A boiler efficiency of 68 per cent is the best that should be assumed for these coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w= 7.60 pounds, and the boiler and furnace efficiency is equal to 64.6 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 8.0 pounds, and the evaporation from and at 212 degrees F. per pound of combustible is 10.14 pounds.

For these coals then the following would be consistent and reliable guarantees:—a boiler efficiency of 68 per cent; a boiler and furnace efficiency of 63 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 8.0 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 10.1 pounds.

ANTHRACITE BUCKWHEAT No. 3 OF 11,000 B.T.U. PER POUND OF DRY COAL.—These coals may be assumed to have a moisture content of 5 per cent and an ash of 25 per cent, giving a calorific value of 14,800 B.t.u. per pound of combustible. The ash from a test for efficiency may be taken equal to 28 per cent of the coal fired. A boiler efficiency of 65 per cent is the best that should be assumed for these coals. From the formula for boiler efficiency, the evaporation from and at 212 degrees F. per pound of coal as fired is obtained, or w= 6.67 pounds, and the boiler and furnace efficiency is equal to 62.2 per cent. The evaporation from and at 212 degrees F. per pound of dry coal is equal to 7.02 pounds, and the evaporation from and at 212 degrees F. per pound of combustible is 9.95 pounds.

For these coals then the following would be consistent and reliable guarantees:—a boiler efficiency of 65 per cent; a boiler and furnace efficiency of 62 per cent; an evaporation from and at 212 degrees F. per pound of dry coal of 7.0 pounds, and an evaporation from and at 212 degrees F. per pound of combustible of 9.9 pounds.

In the same manner the efficiency and evaporation capabilities of any fuel, whether solid, liquid, or gaseous, may be ascertained, but evaporation-guarantee tests are usually made with the coals discussed herein; hence the detail consideration given them.

THE ELECTROCHEMICAL SYSTEM OF AMALGAMATION AND CYANIDATION.

By Elmer Ellsworth Carey.

Electrochemical amalgamation is not yet at the stage of practical commercial demonstration, but it is reported to have advanced so far that devices are actually in experimental operation on the Pacific Coast and the results of the trials are promised for early publication. Mr. Carey reviews here, very concisely and clearly, the basis for belief in the success of the process, and he indicates generally the immense economic effects that would result if the operation succeeds on a large scale.—THE EDITORS.

IN the recovery of precious metals the three methods most generally used by miners, are: (1) The gravity system, used in sluicing, rocking, panning, etc. (2) The amalgamation system, in which values are recovered in the form of amalgams; this system calls for mercury riffles, mercury baths, pan amalgamation or plate amalgamation. (3) The chemical system, in which values are dissolved in certain solutions from which they are recovered by various systems of precipitation. The leaching of values from ore is known as lixiviation and the solvent most generally used is cyanide of potassium, although other solvents are known to metallurgists.

In the gravity system only the particles of gold and platinum heavy enough to be caught in riffles can be saved; the values in placer slimes, all miscroscopic and float gold, and all the values associated with the heavy sands are lost. In all placer operations the assay values of the fine tailings run from 25 cents to $1.00 per ton, and in some cases even higher. There are immense beach, river, and desert deposits on the Pacific coast covering hundreds of square miles containing gold values averaging $1.00 per ton that cannot at present be profitably mined; in some sections hundreds of acres are covered to an unknown depth with gold-bearing material containing values to the amount of over $5,000,000 to the square mile.

When we come to consider the saving of values by amalgamation we find hundreds of devices and machines which are designed to force sand, pulp, etc., into close contact with mercury; hundreds of patents have been issued for devices in which the gangue is passed through a mercury bath; but in practical milling operations only two devices are generally used—the copper plate coated with mercury, and the mercury riffle or mercury well. Only free, clean gold will alloy with mercury ordinarily, and only clean mercury has an affinity for gold.

Gold in slimes will not amalgamate under ordinary conditions, and miscroscopic, rusty and coated gold cannot be saved by standard methods of amalgamation. Gold associated with sulphur, arsenic, lead, zinc, iron and tellurium amalgamates with difficulty or not at all, owing to the fouling and sickening of the mercury. Values in slimes cannot be saved on the standard mill plate by usual methods.

In milling operations when mercury wells are used the surface of the mercury often becomes covered with a coating of fine sulphurets, which diminishes its alloying properties; for this reason mercury wells are not found in many mines in the United States although they are generally used in Australia.

In lixiviation we find endless difficulties; only when certain conditions are present can cyaniding be profitably employed; there are large areas, such as are found in Idaho, where there are hundreds of mines in which the ore is not amenable to cyanide treatment. While in lixiviation theoretically we have an ideal method of gold extraction, yet in practice we find the system hedged about by a multitude of exasperating troubles; generally speaking, cyanide plants are expensive to install, difficult to operate, and the average extraction is not over 85 per cent.

In view of the above very conservative statements regarding the shortcomings of the three popular systems of gold extraction, it is not strange that investigators have long sought improved methods in the metallurgy of precious metals. An examination of the literature bearing on gold saving during the last fifty years shows that here and there some pioneer on the border land between metallurgical science and theory has indicated a path which leads, I am firmly convinced, to the miner's promised land. What every miner wants is a simple, practical, efficient, and economical method which will enable him to recover from 95 to 100 per cent. of *all* the values contained in the auriferous material. Experiments begun in 1859 and carried forward steadily by different investigators in different sections have demonstrated that with a proper application of electrochemical principles, the troubles of the miner will

> Fold their tents like the Arab
> And as silently steal away.

Electrochemical science has devised improved methods for the reduction and refining of the useful materials, and it is not unreasonable to suppose that the same science will point the way to even greater improvements in the metallurgy of gold.

We will suppose that both the positive and negative electrodes or

wires of a battery or dynamo are immersed in water, the two electrodes being an inch apart. The positive electrode is known as the anode, the negative pole as the cathode, and the separating water is called the electrolyte. When the battery or dynamo is in operation, lines of electrical force pass between the anode and cathode through the water, and there take place in the electrolyte a number of reactions; in other words, electrochemical conditions are present in the water, and these conditions form the key to the electrochemical system of amalgamation and lixiviation. An interesting experiment can be tried by any one. Pour a few ounces of mercury into a flat glass or porcelain dish; pour over the mercury half an inch of water containing a pinch of salt or a few drops of acid; immerse the negative wire from a dry battery in the mercury. Now touch the water only with the positive wire and note the activity that at once is manifest. Try this experiment with dirty mercury and note the instantaneous brightening and cleaning of the mercury. Place the positive pole in the mercury and the negative in the water, and the mercury soon becomes foul. Restore the wires to their original positions and note that the mercury clears at once. Grind the mercury in a small mortar with some sulphur or oil and it becomes foul. Now return the fouled mercury to the dish and apply the current as at first. Note the clearing of the mercury and see how quickly the detached globules coalesce. Then remove the mercury and add a pinch of bichloride of mercury to the water; immerse both wires and note how quickly there is a deposition of mercury on the cathode or negative wire. In this simple experiment is the germ of the electrolytic system for the recovery of precious metals. While the theory of electrochemical action has been known for many decades, it is only within the last few years that methods and machines for making a practical use of the theoretical knowledge have been devised.

In 1859 United States letters patent were issued to Henry Brevoort of San Francisco (25,242, August 30), for an arrastra in which amalgamation was intensified by electrochemical means, and in 1862 a patent (34,881) was issued to J. C. Davis for an arrastra in which means were provided for galvanic action. On July 2, 1861, Frank Dibber secured a patent on a barrel amalgamator in which he provided for "local electrochemical action" by adding zinc or iron filings and a mercury salt to the water and pulp. His idea was that local galvanic couples would result, the mercury being deposited on the gold particles (cathodes) by electro-deposition. In 1867 Julio H. Rae was granted a patent for an electro-cyanidation process, which covers the

essential points of the most advanced systems of today. In 1882 Breakell and Haycraft used an electrolytic cyanidation process in South Australia; in the United States patents for similar processes have been issued as follows: 290,295; 491,686; 684,672; 641,808; 364,372; 779,365; 863,934; 504,678; 668,283; 370,366; 363,411. These patents refer to devices in which the pulp is agitated in a tank having the bottom covered with mercury, the stirrers and mercury being electrolytically connected.

Patents for sluices arranged for electrochemical amalgamation have been issued as follows: 492,711; 669,058; 548,265; 460,722; 307,081; 10,507; 285,523; 386,030; 641,360; 590,524; 328,532; 757,-557.*

A patent for a system of electrochemical amalgamation was issued to Sir William Crookes on November 3, 1891, No. 462,535. References to electrochemical amalgamation and cyanidation may be found in the following works. Cyanide Process, by E. B. Wilson, E. M.; A Handbook of Practical Cyanide Operations, by Wm. H. Gage, M.D., F.R.S.; Practical Notes on the Cyanide Process, by F. L. Bosqui; Electric Smelting, by Dr. W. Borchers; Cyaniding Gold and Silver Ores, by H. Forbes Julian and Edgar Smart.

A distinction should be made between electrochemical amalgamation and electrochemical lixiviation. In the first case no solvent is used, and the values are recovered directly in the form of amalgam. In electrochemical lixiviation the action of the solution is hastened by the presence of the electric current, and the values are deposited by electro-deposition on suitable cathodes; the cathode may be lead, copper, aluminium or mercury.

Electrochemical amalgamation may be used in connection with (a) the standard mill plate, (b) mercury wells, or (c) the mercury bath (pan amalgamation). When the usual copper plate is used, anodes are suspended above it close enough to come in contact with the passing flow of water and pulp, which acts as an electrolyte. The copper plate is connected as the cathode. In the paragraph above relating to patents, the numbers of several patents granted for electrochemical sluices are mentioned.

Electrolytic sluices with suspended anodes require more water than the usual mill plate. Mercury may be supplied as in the usual practice, or it may be supplied to the water in the form of a solution of bichloride of mercury. A solution of common salt added to the water

* The Commissioner of Patents, Washington, D. C., will send copies of any patent desired, the charge being 10 cents for each specification ordered.

greatly increases the efficiency of the device. High-grade graphite anodes give the most satisfactory results; there is a grade of graphite made especially for anodes which is superior to the ordinary carbon. A current density of one-tenth to one-quarter ampere per square foot of cathode surface is ample.

Mercury wells such as are described in the second volume of Richard's work on Ore Dressing can be connected electrolytically and their efficiency greatly increased; some tests were made some years ago in South Africa with mercury wells in which the baffle plates were connected as anodes, and I am informed that a similar construction is now being successfully used in California. There are several methods of constructing electrochemical mercury wells and many experiments have shown that the electrolytic mercury well is a very efficient gold saver; there is no fouling or flouring, and no scum or coating of sulphurets collects on the mercury. Electrolytic mercury wells will extract values from slimes and will recover gold that cannot be amalgamated by the usual methods; they require no skilled attention and possess many advantages over plates.

In pan amalgamation, anodes are suspended from the stirrers and the mercury is connected with the negative wire; various systems of pan amalgamation have been described, especially in connection with cyanidation (Parks, Pelatan-Clerici, Molloy, Hannay, etc.), but there is no essential difference in these various processes; the patent numbers of several devices are given in a previous paragraph, and more extended descriptions appear in the books mentioned above.

Turning to electrochemical lixiviation, the claim is made that under electrochemical conditions the cyanide solution is much more active than usual; values pass into the solution which are lost in the ordinary systems; the time of treatment is reduced and the extraction increased, while there is a decrease in the operating cost; precipitation by electro-deposition goes on simultaneously with the leaching process and the usual troubles are eliminated; a molecule of cyanogen after taking up a particle of gold, is released as nascent cyanogen, having greatly increased affinity for gold and silver. The solution is constantly regenerated, the loss of cyanogen being negligible. The larger particles of gold are amalgamated directly without passing into the solution. In electro-cyanidation the pulp and solution are agitated in a shallow tank having the bottom covered with quicksilver (cathode); revolving stirrers cause the pulp to travel with a circular motion over the quicksilver for an hour or two; this is equivalent to passing the pulp over several miles of mercury surface. During this period

the values are amalgamated directly or pass into the solution and are precipitated by electrolysis, the extraction averaging 97 per cent. All ores, so far as known, are capable of successful treatment by means of electro-cyanidation.

Within the next few years, I expect to see the electrochemical cyanidation process perfected to such an extent that it will become automatic and continuous; pulp from the mill will continuously enter a series of tanks, and from the lower end of the system the tailings will be continuously discharged. In fact plans for such a continuous system have already been prepared.

At present electro-cyanidation is in the experimental state, although it was once used quite successfully for several months at the De Lamar mine in Idaho; electro-deposition (Siemens-Halske process) is successfully employed in many mines in South Africa.

Let us consider again electrolytic amalgamation, taking as a text the so-called base or rebellious ore. When low-grade pyritic ore is cruched to 100, 150, or 200 mesh, practically all the gold is released as free gold; but only a small percentage of the assay value can be recovered by the usual mill plate. Gold when in a very finely divided state quickly becomes coated with argillaceous, talcose, sulphurous, or arsenious coverings, and it will not amalgamate; very fine gold easily acquires coatings, gaseous or otherwise, which effectually prevent the amalgamation contact; values in slimes cannot be extracted by the usual mill plate; particles of gold in placer deposits sometimes become coated by local galvanic action, and we have rusty, silicious, or cupreous coatings which effectually prevent amalgamation. With electrochemical conditions, all these difficulties are automatically overcome, and the broad statement can be made without fear of successful challenge that all values not encased are recovered, including platinum and the values associated with black sand.

In electrochemical amalgamation and cyanidation, a few pounds of common salt should be added to every ton of ore or pulp; by electrolysis the chloride of sodium is reduced to nascent chlorine and nascent sodium. Bichloride of mercury is also added to the water or solution; this salt under electrolytic action evolves nascent chlorine and mercury. As a result of these reactions, an alloy of nascent sodium and mercury is formed; this alloy absorbs nascent hydrogen produced by the decomposition of the water, and the resulting compound, known as hydrogen-sodium amalgam, has a powerful affinity for gold; in fact no compound known to science has a more powerful amalgamating action. The water and solutions become charged with

nascent chlorine and hydrogen; these gases instantly destroy foul or greasy substances in the pulp; rusty or coated gold is quickly cleaned, the gases mentioned reducing all oxides. Nascent hydrogen reduces oxides at normal temperature. As a result of this cleaning and reducing action, gold particles have been freed from all substances that would prevent amalgamation, and amalgamation takes place at the first contact with the mercurial surface. Electrochemical action keeps the mercury in a perfect state, and it also prepares the gold for amalgamation; in the mercury riffle or well we have the necessary fall to bring every particle of gold into intimate contact with the mercury surface. And as the quickened mercury surface is at all times exposed to the passing pulp, we have the most perfect conditions possible for effective amalgamation. We have therefore all the specifications which would be called for in an ideal amalgamation device—simplicity, low cost, ease of installation and operation, absence of skilled attendance, large capacity, and high percentage of extraction. Those who wish a more detailed account of the chemical and electrochemical processes are referred to a paper on electrochemical amalgamation in the May, 1909, issue of the *Electrochemical and Metallurgical Industry;* to the *Mining Journal* (London) for June 12, 1909; and also to Vol. I., page 205 of the *Proceedings of the London Institution of Mining and Metallurgy.*

In using the electrolytic system in placer and dredge operations, the auriferous material is at first passed through a series of screens until a 10 or 12 mesh concentrate is obtained; the coarser particles of gold will be saved by the usual riffle system. The 12-mesh concentrate, containing the values ordinarily lost, is then passed over the electrolytically connected plates or riffles of suitable length and 95 per cent. of all values not encased are recovered at a trifling expense. The successful application of the electrolytic system on gold dredges would double the net savings. Under the present system the fine tailings of the dredges generally contain greater assay values per ton than the amount of gold recovered; that is, on ground where 15 cents per yard is recovered it will generally be found that the assay value of the tailings is 25 or 30 cents per ton. In ten years I estimate that gold and platinum to the amount of $25,000,000 have passed through the tail sluices of California dredges and have been forever lost. Within the next ten years the value of the lost gold in the dredge tailings will exceed $40,000,000, unless some new system of extracting these elusive values successfully is discovered.

LATTER-DAY DEVELOPMENTS OF THE AMERICAN LOCOMOTIVE.

By H. Keith Trask.

II. SUPERHEATING, FEED-HEATING, BOILER AND FIREBOX DESIGN, AND VALVE MOTIONS.

In a preceding article Mr. Trask reviewed the evolution of wheel arrangements and of compounding, as exhibited in American practice. The installment presented this month completes his study.—THE EDITORS.

IT is a fact to be deplored, but one that cannot be gainsaid, that American locomotive practice has followed rather than led European practice in matters of design relating purely to increased efficiency from the standpoint of economy. This condition has been brought about chiefly because in Europe fuel is so much more expensive than it is in the United States that it has always been imperatively necessary to get the utmost possible benefit from every pound of coal burned in the locomotive firebox. This condition led European designers to consider the advantages offered by superheated steam long before the question was seriously taken up in America. However, as the disadvantages attending the use of the compound locomotive were realized the advantages offered by superheating were more thoroughly canvassed. Briefly summed up, the advantages of superheated steam over saturated steam are as follows:

I.—Increased volume; the volume of superheated steam has a rate of increase directly proportional to the rise of temperature.

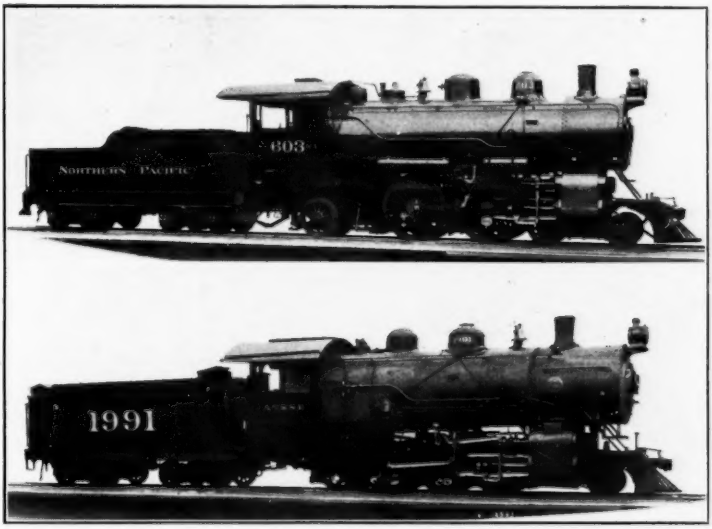
II.—A reduction of condensation in the cylinders and steam passages. With saturated steam a large percentage of the total quantity precipitates and passes through the cylinders without doing any work.

III.—Low thermal conductivity. Saturated steam is a good conductor of heat while superheated steam is not.

IV.—Reduction of back pressure, since a smaller volume and weight is required than with saturated steam to do a given amount of work.

V.—Increased hauling capacity, since the mean effective pressure is higher, on account of the increased fluidity due to the tendency to complete gasification.

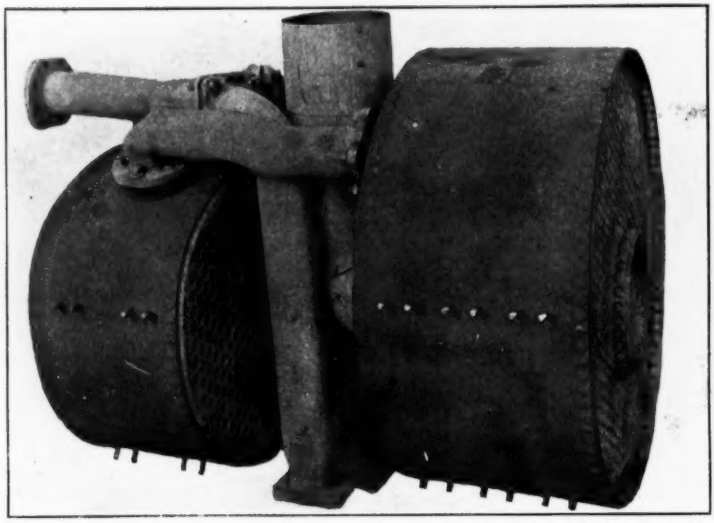
VI.—Lower maintenance costs for the boiler, since for a given power a lower working pressure may be effectively employed.



BALDWIN LOCOMOTIVES OF 1909 WITH SUPERHEATERS.
Above, a Northern Pacific engine with water-tube superheater; below, a Santa Fe with smoke-box superheater.

As developed for use on American railroads the superheater is of two types, the smoke-box, chiefly advocated by the Baldwin Locomotive Works, and the fire-tube, a modification of the design of Wilhelm Schmidt, a German engineer, by H. H. Vaughn of the Canadian Pacific Railway. While both types were originally introduced several years ago, it is only within the past twelve or eighteen months that the American railroad world in general has awakened to their possibilities, and they are being applied to many new engines now building for various roads. The Canadian Pacific was the first road to adopt the fire-tube superheater exclusively, while the Santa Fe, although not the first road to test the smoke-box design, was the pioneer in adopting this device as a standard.

The fire-tube superheater, as its name implies, is a design wherein the superheater tubes are inserted in large fire-tubes that take the places of a certain number of the ordinary boiler flues. The superheater tubes run to the rear of these fire-tubes, where they meet a return bend just ahead of the back flue sheet, and return to the header at the front flue sheet. They are so arranged that the four superheater tubes in each fire-tube form a unit that may be disconnected, in the event of any trouble arising, without disabling the rest of the

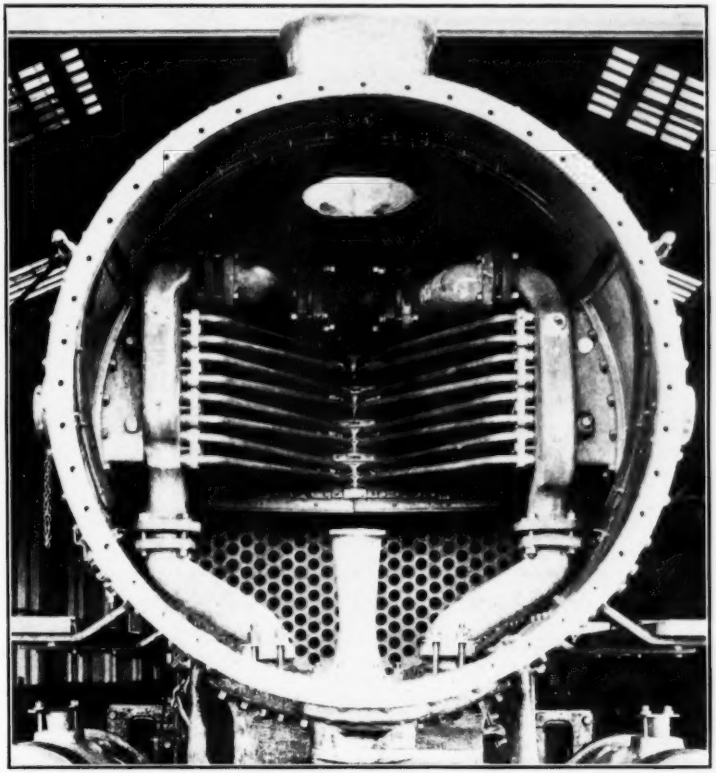


THE JACOBS SMOKE-BOX SUPERHEATER AS CONSTRUCTED FOR LOCOMOTIVES ON THE A., T. & S. F. RY.

The gases are drawn through the tubes and around both rear and front sections, then back through the large cylindrical hole in the front section and the petticoat pipe shown, and out the stack. The steam is conducted from the dry pipe to the front section, back to the rear section, and thence to the cylinders. The boiler is not deformed nor is any heating surface sacrificed by the application of the superheater to existing locomotives.

superheater. The steam from the throttle must traverse a distance equal to twice the length of the boiler tubes exposed to the hot flue gases, and in so doing attains a high degree of superheat.

In the smoke-box superheater the steam from the throttle arrives at the front flue sheet in the ordinary manner, but thence instead of being conducted directly to the cylinders by the ordinary smoke-box steam pipes it enters two long cast-steel drums, one on each side, of the upper part of the smoke-box, their axes parallel to the axis of the boiler and to each other. These drums are connected directly to the tee-head of the dry pipe. On the bottom of the smoke-box a similar pair of drums is connected to the live-steam passages in the cylinder saddle. The two right-hand and two left-hand drums are connected by rows of tubes bent to the radius of the smoke-box and divided into sections, each section having about the same cross-sectional area as would the ordinary steam pipe, in such a manner that the steam must pass up and down through the tubes several times before entering the cylinders. Baffle plates are provided whereby the gases and products



FIRE TUBE SUPERHEATER, FOR WABASH-PITTSBURG TERMINAL CO., CONSOLIDATION TYPE LOCOMOTIVE.
American Locomotive Co.

of combustion are made to circulate between all the superheater tubes before finally passing out of the stack.

The chief advantage claimed for the fire-tube superheater is economy of operation due to the high degree of superheat attained.

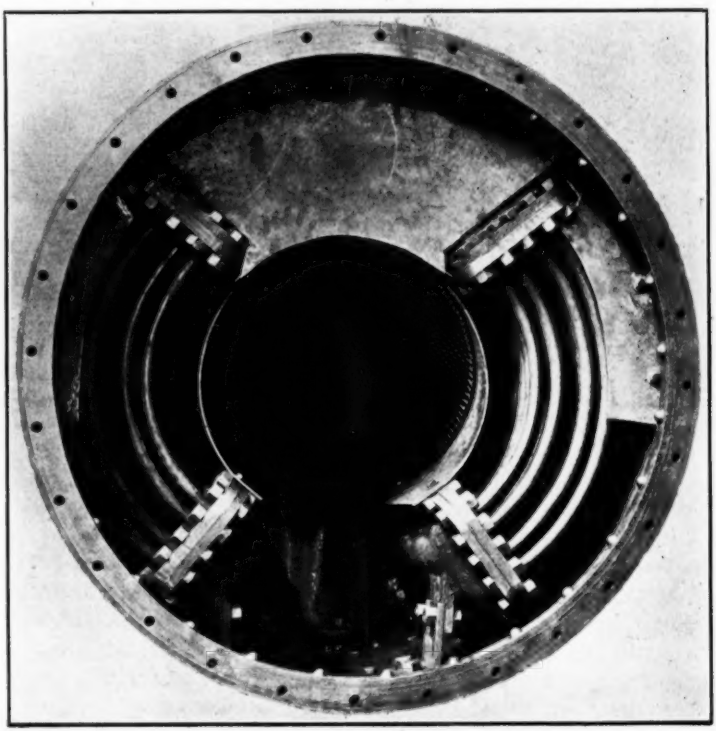
Its chief disadvantage is that, on account of the large fire-tubes, the boiler is robbed of a certain amount of heating surface, and that in their swift passage through the flues the gases do not give up all the heat they should, and, consequently, they pass out of the stack at a wastefully high temperature. Minor objections are the difficulty of maintaining packing, and the necessity for special preparation of the locomotive boiler to apply this type of superheater.

The smoke-box superheater does not attain so high a degree of

superheat, but its advocates claim that what it loses in theoretical efficiency thereby, it more than regains from a practical standpoint, in its simplicity and ease of application and operation. Being placed altogether in the smoke-box, it does not rob the boiler of any of its heating surface nor does it require any special arrangements for its installation. All the gases which are circulated through it have already done their work in the boiler flues, and, consequently, pass out of the stack at a materially lower temperature than in the case of the fire-tube type.

One advantage, and an advantage that would outweigh many drawbacks in a part of the country where bad water prevails, both types of superheaters possess in common; they obviate all the trouble and annoyance of priming in the boiler. No matter how much entrained water enters the dry pipe with the steam, the steam that reaches the cylinders is an absolutely dry and fluid gas.

The slightly increased difficulties of lubrication with superheated



SMOKE-BOX SUPERHEATER AS APPLIED TO IDAHO NORTHERN LOCOMOTIVE.
Baldwin Locomotive Works.

steam are as nothing compared with the trouble and annoyance experienced in attempting efficient cylinder lubrication in bad-water districts where saturated steam is used.

Feed-Water Heating.

The logical complement of the superheater is the feed-water heater. This device is, as yet, in the experimental stage for the locomotive, but there appears no good reason why on very large locomotives it should not have a place. The pioneer form of feed-water heater for a locomotive in the United States was a modification of the smoke-box superheater applied to an engine of the Central of Georgia Railway by the Baldwin Locomotive Works.

On the large Mallet compounds for the Southern Pacific, previously referred to, a feed-water heater of a different type has been installed. In this instance the boiler is very long, some 51 feet, but the distance between front and back flue sheet of the boiler proper is but 21 feet, thus keeping the length of the flues within practical limits.

Directly in front of the flue sheet is a short combustion chamber, and forward of this combustion chamber another section of the boiler shell containing the same number of flues as the barrel of the boiler proper. This section is short, the flues being but 5 feet 6 inches in length. The feed water is pumped first into this section of the boiler through a check placed at the center line in the usual manner. No steam is generated herein, but the temperature of the water is materially raised. As this chamber fills up, the incoming feed raises the pressure of the water until it is sufficiently high to lift the check between the feed-water heater and the boiler proper, when the heated water passes into the boiler to be converted into steam. A superheater, or more properly a re-heater, is placed in the smoke-box of these locomotives to reheat the exhaust steam from the high-pressure cylinders before it passes into the low-pressure cylinders.

Piston Valves.

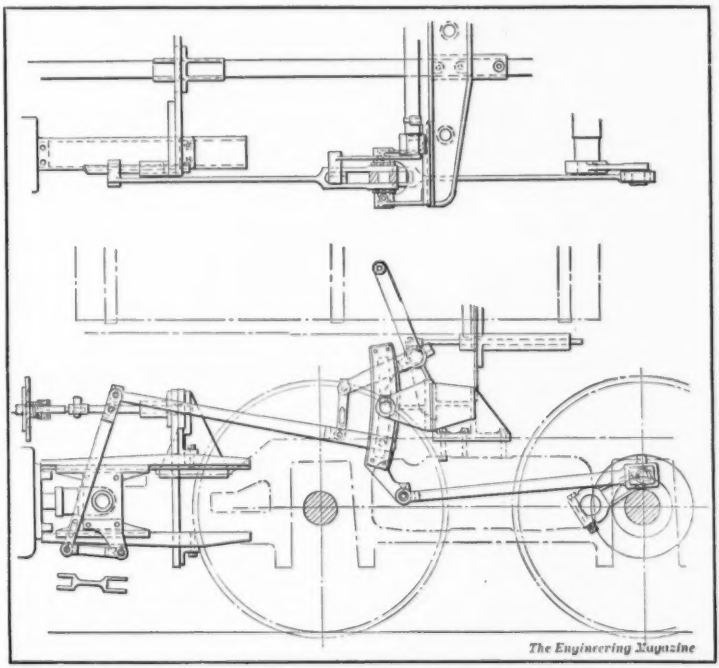
In the development of the four-cylinder type of the compound locomotive it became necessary to employ the piston valve to secure the desired steam distribution to the cylinders. Previous to the introduction of the compound, these valves had been employed to a certain extent although not very successfully. The piston valve in its simplest form was essentially the same as the slide valve, except that it was circular in section, and was contained in a cylindrical steam chest. By reversing the plan universally adopted with the slide valve and making the piston valve an internal admission valve it was possible to secure practically perfect balance. In the earlier years of its growth the chief opposition to the piston valve arose from the fact that it was

difficult to provide means to relieve the cylinders of excessive pressure due to sudden charges of water, and to relieve them when drifting. When it was found desirable to adopt this form of valve for the compound engine it was not long before means were found to overcome these difficulties and the piston valve rapidly grew in favor. Today it is extensively used on heavy engines of all types, and so perfect are the devices for relieving excess pressure that the piston valve is rapidly distancing the slide valve in popularity.

Valve Motions.

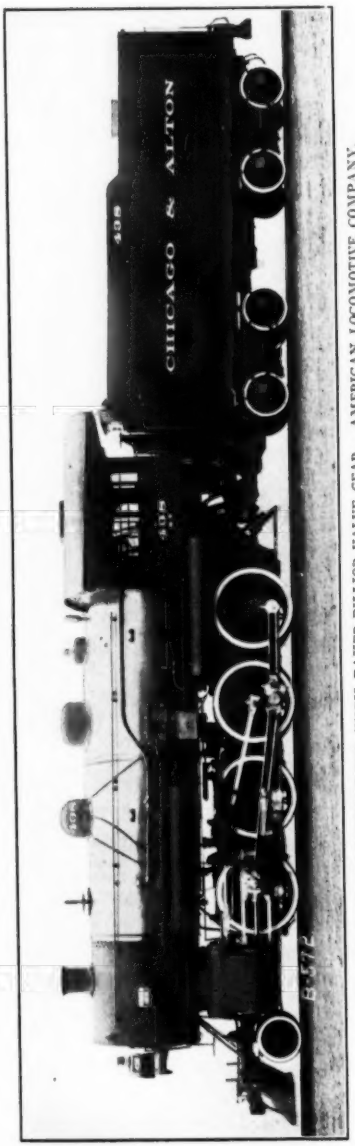
One of the most fertile fields for experimentation in the whole subject of mechanical design has been the locomotive valve gear. From the days of the first locomotive, inventors in every country have attempted to improve the steam distribution, and, incidentally, to make their fortunes. Most of these designs never got beyond the inventor's drawing board; some have survived the ordeal of the Patent Office, and a few, either through some inherent merit, or by the pull of the inventor have been placed on locomotives for trial. The American inventor has been peculiarly prolific in this field, and the names of Strong, Alfree-Hubbel, and Baker-Pilliod have made a sufficient impression to be noted. Despite these various assaults, however, the Stephenson link motion has remained firmly intrenched as the universal valve gear for American locomotives up to a very recent time. Early adopted by the pioneer builders, it proved its superiority over all rivals again and again. As the weight of locomotives and, consequently, the weight of the reciprocating and revolving parts increased, the various parts of the Stephenson motion became so large as to be unwieldly. Moreover the inertia of the parts introduced derangements of the steam distribution. All American designs offered as substitutes for the Stephenson link having been tried and rejected, we again turned to Europe and borrowed the Waelschaerts valve motion. This motion was evolved about 1846 by Aegides Waelschaerts, then mechanical engineer of the Belgian State Railways, and has been extensively used in Europe. The Waelschaerts gear is a radial gear differing from the Stephenson in that, while the Stephenson motion has the property of a variable lead, changing with the various points of cut-off, the lead of the Waelschaerts gear is a fixed factor at any point of cut-off. Unlike the Stephenson gear the entire mechanism is outside the wheels. The mechanism consists essentially of a link having a fixed center about which it is free to revolve, and connected to the valve by a radius rod which is free to slide up and down throughout the arc of the link. The link is usually hung by its fixed center to a yoke passing across the frames for that purpose. Mo-

tion is imparted to this link by an eccentric rod which is connected at one end to the bottom of the link and at the other end to a return crank that is attached to the main crank-pin of the locomotive. The radius rod, as its name implies, has a length coincident with the radius of the link. At its forward end this radius rod is attached to the valve rod which is steadied by some form of guide. From this guide another lever known as the combination lever extends downward and is at-



WAELSCHAERTS VALVE GEAR APPLIED TO C. & N. W. 10-WHEELED LOCOMOTIVE.
Baldwin Locomotive Works.

tached to the main cross-head by a short link. The valve, therefore, derives its motion partly from the main crank-pin and partly from the cross-head. The return crank on the main pin being set at an angle of 90 degrees to the pin, it is obvious that the valve would have no lead were all its motion derived from the main pin. The cross-head connection furnishes the lead, and the amount is directly proportional to the vertical distance between the centers of the pins which attach the radius rod and combination lever to the valve stem. Since the radius rod is free to slide from end to end of the link, and the



CHICAGO & ALTON LOCOMOTIVES WITH BAKER-PILLIOD VALVE GEAR. AMERICAN LOCOMOTIVE COMPANY.

eccentric rod is connected permanently to the lower end of the link, it follows that when the radius rod is below the center of the link the valve motion becomes a direct motion, the link being in reality a rockshaft having both members on the same side of the center and in the same plane, while with the radius rod above the center of the link the link becomes a rocker shaft with its members on the opposite sides of the center, and the valve motion becomes indirect, thus reversing the motion of the whole mechanism and consequently the engine. It is also apparent that since the lead is derived from the motion of the cross-head, the amount of lead is permanently fixed, and can be altered only by re-designing the whole gear.

The advantages of this gear are obvious. It is accessible for inspection and lubrication, and, consequently, receives more attention from enginemen. It is so much lighter than the Stephenson motion for any given engine that the wear is very much lessened, and the physical labor of reversing a heavy locomotive very much reduced. It is readily adaptable to any design of locomotive, since it does not interfere with any parts that may be placed between the frames, and it makes possible the introduction of heavy stiffening castings at parts

of the frame where they are much needed. So rapid has been its growth in popular favor that, practically unknown in America in 1905, it is today specified on nearly all large engines and not a few small ones.

The Baker-Pilliod valve gear, which was mentioned in a preceding paragraph as one of the various attempts of American inventors to improve upon the Stephenson link motion, is of quite recent origin and is being applied to a sufficient number of locomotives on various railroads to make the principle upon which it acts of general interest.

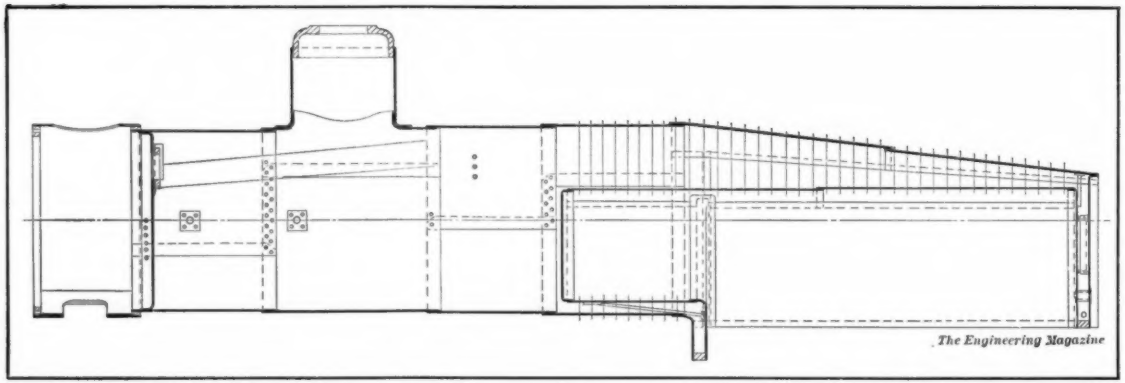
The principal object the designer had in view was the elimination of the radial link which is so essential a part of the mechanism of both the Stephenson and Waelschaerts motion. It is impossible to eliminate the slip of the link block in either of these gears, and, while in this respect the Waelschaerts gear presents the advantage of a fixed link as against the Stephenson shifting link, this slip necessarily causes a slight derangement of the functions of the gear.

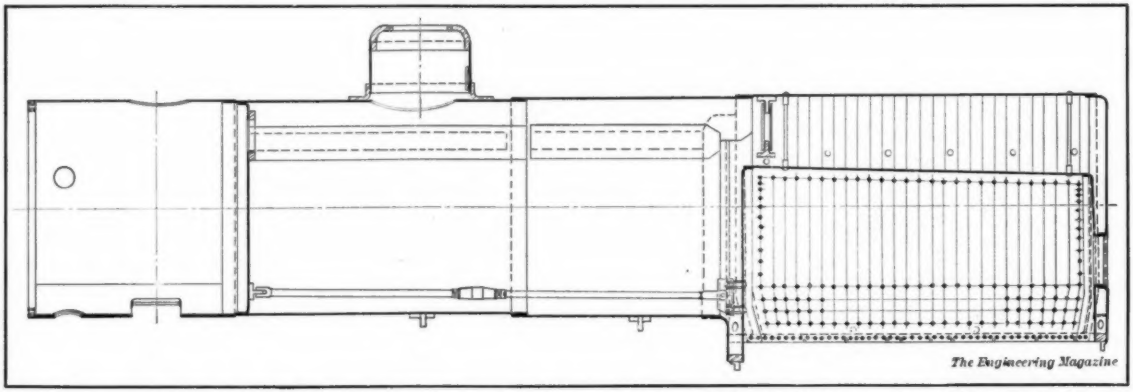
The Baker-Pilliod gear resembles the Waelschaerts, in that all the parts are outside the frames, and that it employs a return crank from the main pin and a crosshead connection to impart motion to the main valve. A reference to the illustration will show that a combination of bell cranks and linkages is substituted for a radial link for the purpose of combining these two sources of motion and reversing the direction of the motion when it is desired to reverse the engine.

Locomotive Boilers.

The development of the locomotive boiler has not, in a measure, kept pace with the strides made in other important details of the machine. Very early in the history of the American railroads the various experimental types crystallized into a type of boiler of which the general characteristics remained the same for many years. This was the cylindrical barrel fire-tube boiler with a rectangular firebox. The cylindrical portion of the shell immediately in front of the firebox was usually increased in diameter in order to give more space for steam over the firebox crown sheet. This enlargement caused this style of boiler to be called wagon-top, and the wagon-top boiler, or the straight-top boiler of generally similar form, was the only type used in America to any extent up to 1877. The grate area of this boiler was restricted, inasmuch as the width was confined to that which could be obtained when the boiler was set between the frames, or, at most, on top of the frames between the wheels, and the length was limited to the distance to which the fuel could be effectively fired.

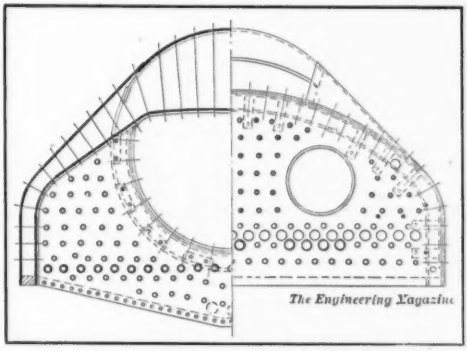
In the mining of anthracite coal large banks of very fine dust,



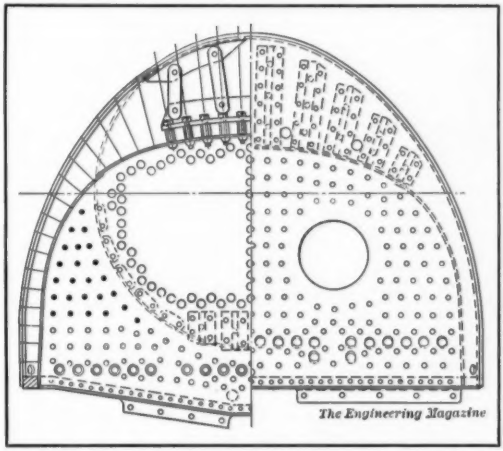


ABOVE, OLD-STYLE WOOTTEN BOILER WITH COMBUSTION CHAMBER; BELOW, MODIFIED WOOTEN BOILER WITHOUT COMBUSTION CHAMBER.
Baldwin Locomotive Works.

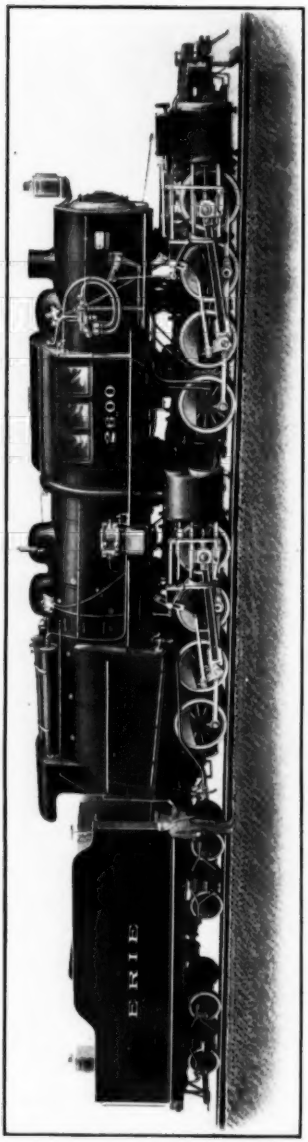
which is screened out of the coal in passing through the breaker, rapidly accumulate. It was impossible to burn this fine coal, or culm, in any ordinary firebox or domestic stove, and the material was consequently a dead loss to the coal companies. In 1877 John E. Wootten, superintendent of motive power of the Philadelphia and Reading Rail Road, designed a firebox to burn this culm which was very successful, and, in a modified form, is widely used today by a number of the Eastern coal roads. In his firebox design Mr. Wootten raised the center of the boiler sufficiently to permit spreading the firebox over the top of the wheels, and making its total width practically that of the limit of width of the locomotive. The strength was made as great as was possible for effective firing. A short combustion chamber was applied, and a very fine grate used. In later designs the combustion chamber has been omitted, and the firebox altered in minor details. It is now sometimes used for bituminous or semi-bituminous coal, owing to the low rate of combustion which the large grate area renders possible.



CROSS SECTION OF OLD-STYLE WOOTTEN BOILER.



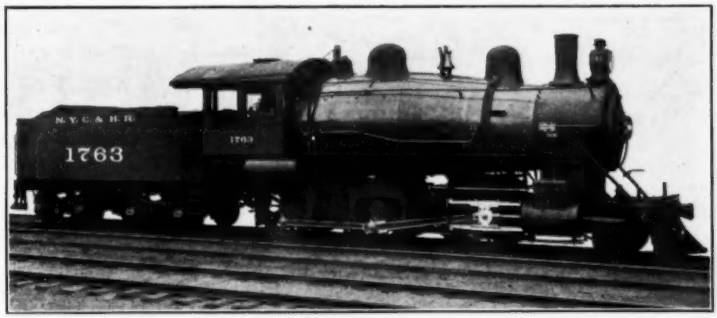
CROSS SECTION OF MODIFIED WOOTTEN BOILER WITHOUT COMBUSTION CHAMBER.
Baldwin Locomotive Works.



MALLET TYPE LOCOMOTIVE WITH WOOTTEN FIREBOX AS BUILT FOR THE ERIE BY THE AMERICAN LOCOMOTIVE CO.

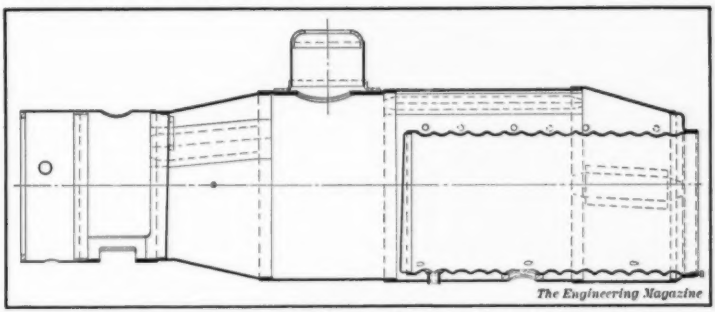
From the time of Wootten until the latter eighties no attempt was made to introduce any radical innovations in the locomotive boiler. About 1887 or 1888 George S. Strong evolved a design which had no real influence in American practice, but is interesting in view of a later development along somewhat similar lines. The Strong boiler consisted of a cylindrical shell, constructed in the ordinary manner, with a combustion chamber at the rear end. Connected to this combustion chamber were two cylindrical fireboxes whose axes lay parallel in the same horizontal plane. This boiler did not meet with much favor and soon disappeared from view.

In 1901 Cornelius Vanderbilt designed a firebox with the object of dispensing with stay-bolts, a most annoying item of boiler maintenance. The Vanderbilt boiler consisted of an ordinary cylindrical barrel with an extended wagon top. Instead of the usual rectangular firebox, a cylindrical corrugated furnace of the Morison type was employed. This furnace tube, which was of large diameter, was suspended eccentrically in the rear end of the boiler with its axis inclined rearwardly, and below the axis of the boiler. It was supported at the rear end by being flanged and riveted to the back boiler head, and at the forward end the weight was carried partially by several rows



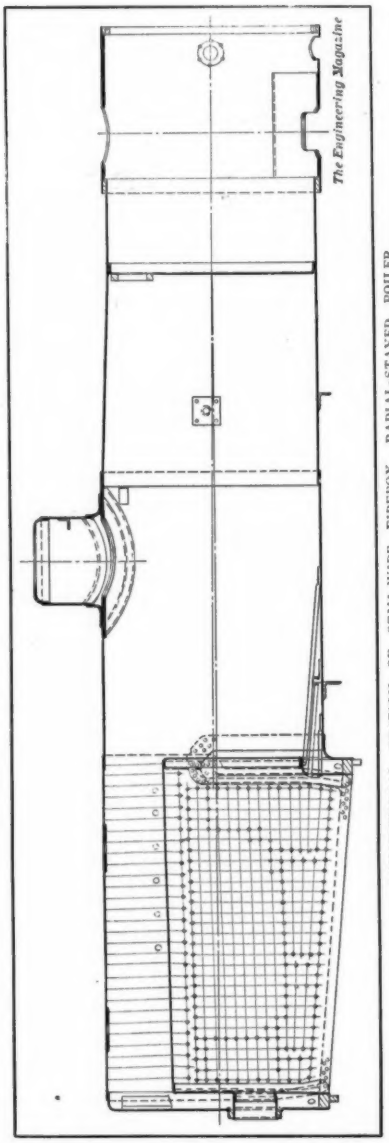
SCHENECTADY LOCOMOTIVE FOR NEW YORK CENTRAL, WITH VANDERBILT FIREBOX.
American Locomotive Co.

of sling stays, and partially by a circular steel casting which formed a man hole between the fire-tube shell and the boiler shell at the bottom. A similar man-hole casting was provided about half way to the rear of the firebox. These two man-hole orifices served for the removal of the ashes. No stay-bolts whatever were used, the corrugations of the fire-tube rendering it amply strong to resist any tendency toward collapse. The grates were set inside of the tube upon suitable frames at a distance of about one-third of the diameter from the bottom. A sheet-iron liner was provided under the grates to protect the corrugated tube from injury by the hot ashes. About two-thirds of the distance forward was utilized for grate area, the remaining one-third forming a combustion chamber separated from the grates by a firebrick wall. The orifice at the rear end of the tube was closed by a casting lined with firebrick and provided with a suitable firedoor.



LONGITUDINAL SECTION OF LOCOMOTIVE BOILER WITH VANDERBILT FIREBOX.
American Locomotive Co.

This boiler did not prove as successful as its inventor had hoped. While the absence of stay-bolts was a considerable advantage, this advantage was more than compensated by the drawbacks presented

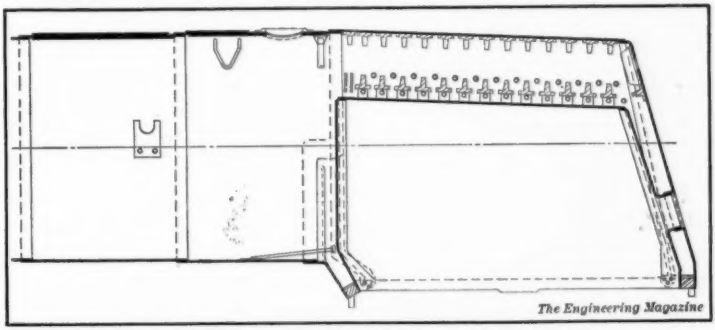


LONGITUDINAL SECTION OF SEMI-WIDE FIREBOX, RADIAL-STAYED BOILER.
American Locomotive Co.

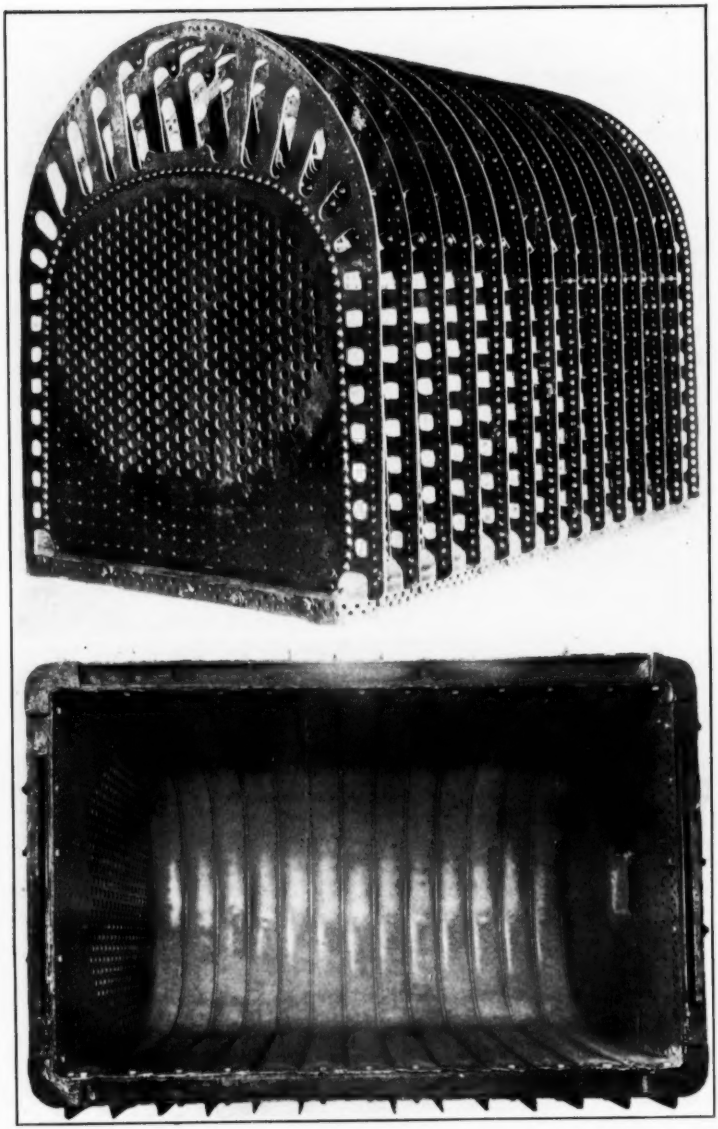
by the necessarily restricted grate area. One of the claims put forth by the advocates of the Vanderbilt boiler was that the corrugations of the Morison tube would present sufficient additional heating surface to compensate for the restriction of grate area. This did not prove to be the case in practice. Moreover the large radiating surface of the back-head casting, protected from the fire only by a single layer of firebrick, and lagged on the outside with asbestos, made the cabs of the locomotive extremely hot, and imposed a genuine hardship on the engine crew.

In an endeavor to remedy some of the unsuccessful features of the Vanderbilt design the Baldwin Locomotive Works produced a boiler with three Morison tubes suspended in the boiler shell with parallel axes, and arranged in section as an inverted cone. The three fire-tubes were connected to a common combustion chamber and were arranged for burning oil as fuel. This arrangement did not meet the expectations of its designers.

While these various unsuccessful attempts to improve the locomotive boiler were being made the need of a firebox with a larger ratio of grate area total heating surface than was offered by the old style narrow firebox was daily being more keenly felt. The Wootten firebox, while it offered this advantage, had attendant disadvantages that rendered it unsuitable in many localities, and for certain classes of traffic. The great width of the Wootten firebox made it necessary to place the cab on the center of the boiler ahead of the firebox, thus separating engineman and fireman. In some States this was considered so grave a menace to safety that legislation was attempted to compel the carrying of a third man upon the engine as a precautionary measure against the sudden disability of the engineman which might pass unnoticed by the fireman until disaster was unavoidable. The great width of the firebox also precludes the use of a wheel sufficiently large for high speed in some types of locomotive owing to the necessity for keeping the center of gravity within reasonable limits. These considerations led to the gradual evolution of a firebox much wider than the older types, but not so wide as to preclude placing the cab at the rear end of the boiler. This type of firebox is now employed almost exclusively for locomotives of large dimensions. It is usually of the crown-bar or radial-stayed type with the back head sloped forward from the bottom to the top to give more room in the cab. In some instances the flat-topped Belpaire type of firebox has been used, although this style of box is usually considered more difficult to maintain than the radial stayed. A firebox of this character for a typical consolidation locomotive with a 22-inch cylinder would have a grate area approximating 50 square feet, as against about 30 square feet for the old



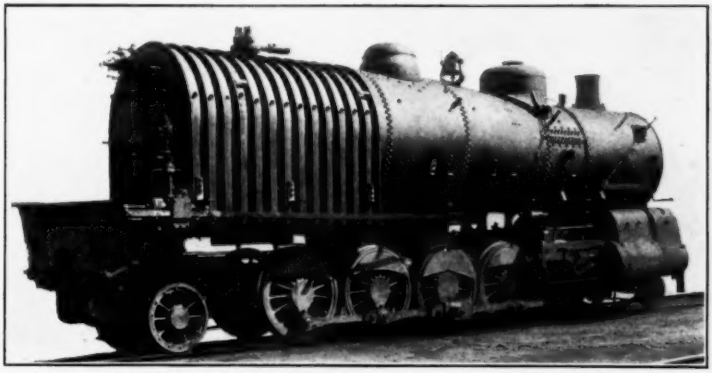
FIREBOX SECTION OF SOUTHERN PACIFIC MALLET LOCOMOTIVE.
Baldwin Locomotive Works.



THE JACOBS-SHUPERT FIREBOX AT VARIOUS STAGES OF ASSEMBLY AND CONSTRUCTION.

narrow type, and from 80 to 100 square feet for the Wootten type of firebox.

It is clearly recognized that a locomotive boiler in which the use of stay-bolts can be avoided, and in which the attainment of this end will not entail complications sufficient to neutralize the advantages gained, is a very desirable thing. The most recent effort in this line is that of Messrs. Jacobs and Shupert of the Santa Fe. This firebox is built up in sections integral with the shell of the boiler, formed of plates flanged into a U or shallow trough section and bent around to the radii of the boiler shell and the firebox. The convex side of the firebox plates is presented to the fire and the plates of the outside shell occupy the same relative position—that is, with the convex side turned inward toward the water space. The various sections are connected to each other, and as a whole, by transverse bulkhead plates whose outline is that of the space between the outside shell of the boiler and

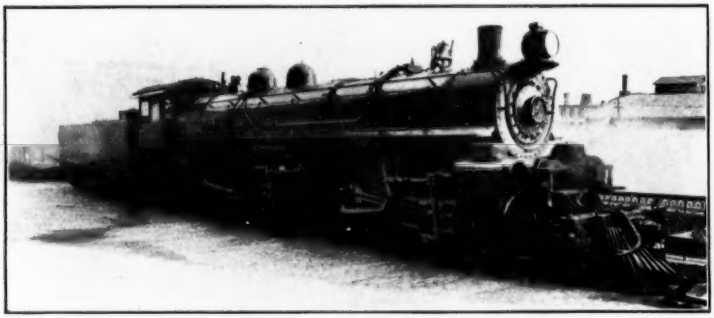


SANTA FE LOCOMOTIVE WITH JACOBS-SHUPERT FIREBOX, NEARING COMPLETION.

the firebox shell. Through rivets connect these bulkheads with the flanges of each adjoining set of outside and firebox plates. The bulkhead plates are spaced about 8 inches from center to center, and as will be seen, are designed to act as stays to the shell and firebox. In addition to the stay-boltless feature the inventors claim for this boiler that, owing to the slight corrugations in the firebox sheets, where they are joined by means of the bulkhead plates, the effective firebox heating surface is somewhat increased.

It would be obviously unfair to criticise a design that is, as yet, untried.* The weak feature of this firebox would seem to be the

*Since this was written extended trials of the Jacobs-Shupert firebox have been made on the Santa Fe with results that are reported to be very satisfactory. The firebox has been adopted on the four huge Mallets just completed for the Santa Fe by the Baldwin Locomotive Works, and on locomotives built in the Santa Fe shops.



MALLET COMPOUND LOCOMOTIVE FOR PASSENGER SERVICE, A., T. & S. F. RY.
Total weight of engine and tender 600,000 lb.; weight on driving wheels 268,000 lb. Length over all 104 ft. 11½ in. Equipped with Jacobs-Shupert firebox and Buck two-stage superheater.

number of seams to caulk, that are directly exposed to the fire. At the point of junction of each section with the next there are two seams that run transversely entirely around the firebox from the mud-ring on one side to the mud-ring on the other. It would also appear that it may be difficult to form a satisfactory connection between the sectional sheets of the firebox and the mud-ring.

From the foregoing review it may be seen that the past decade has indeed witnessed a radical development in the American locomotive. Some of the most far-reaching improvements in design have occurred during the past five years. Had any man seriously prophesied five years ago that we should have locomotives running on our roads with sixteen wheels connected he would have been a target for ridicule and, probably, his sanity would have been a matter of investigation. Today it would be a bold man who would venture a conjecture as to where the increase is to stop.

That the Mallet type of engine is to be the freight locomotive of the future seems reasonably certain. In passenger service there are several lines of development possible. That some form of balanced engine will be required for high speed seems probable. Whether this balanced engine shall be a four-cylinder compound or a three- or four-cylinder simple engine using superheated steam, time alone can show. One thing is certain; in spite of the predictions of those who would have us believe electricity to be the power of the future, the steam locomotive must remain the principal factor in long-distance land transportation for many years to come. The introduction of the large Mallet engine has robbed the electrical advocates of one of their stock arguments, that we have arrived at the limit of size and capacity in the steam locomotive.

ORGANISATION BY PRODUCTION FACTORS.

By A. Hamilton Church.

III.—Elements of the Land Factor.

In the first article of the series, which appeared in our October issue, the author defined his purpose. It is to avoid the uncertainties and errors of averaging and apportioning a general expense account, by recognizing from the outset all the important factors in production—many of them, in his view, quite as distinct and determinable as the wages factor—and reducing them to unit values which can be directly applied to the product they serve. The first paper was devoted to "The Definition of Factors other than Labour," and the second to "Production Factors as Related to Cost Accounts and Staff."—The Editors.

PROVISION of a site on which buildings may be erected is of course antecedent to all other steps in commencing to manufacture. Whether unoccupied land is specially acquired, or a factory is already erected, the site value of the land and certain outgoings and expenditure incident to it remain separate items, and are reducible to unit value. It will be admitted, after brief consideration, that the unit value of sites may vary within wide limits. In large cities, especially, the cost of land and the outgoing expenditure on what may be a cramped and unsatisfactory site frequently amounts to a noticeable burden on manufacture. The high assessments and heavy incidence of taxation on such city sites is giving rise (particularly in Great Britain) to a marked tendency to remove large works to country districts where land can be acquired at something near agricultural value. This tendency develops in spite of the disinclination of skilled labour to live away from the pleasures and excitements of large towns.

Low unit-value is however not the most important consideration in the selection of manufacturing sites. Transport facilities take first place. Much depends also on the character of the labour employed. Some classes of business, requiring the proximity of large reserves of unskilled labour to be drawn on at short notice, cannot be carried on away from crowded centres of population. The neighbourhood of raw materials is also in some cases a factor in determining the choice of sites. But an ordinary engineering works has a wider latitude of choice than many others, and given good transport facilities, its location depends rather on the scale and extent of the proposed undertaking than on the neighbourhood of labour or materials. The

scale of the undertaking, however, has an important bearing on the question.

A comparatively small factory must of necessity locate itself in the neighbourhood of an existing town where housing and marketing accommodation for its employees can be obtained. A concern established, or about to be established, on a very large scale, with ample capital, is more independently placed as regards its choice of a site, because it can and frequently does not only provide its own manufacturing premises, but undertake also the function of a speculative landowner, and erect model villages with housing and marketing accommodation, and all the adjuncts necessary to the social life of a community. Many of these model settlements have attracted much public attention and have been described in detail in THE ENGINEERING MAGAZINE, but we need not consider them in this inquiry further than to remark that they have nothing to do with and should be kept entirely separate and distinct from the manufacturing enterprise proper. This principle applies whether half a dozen cottages are in question or a complete community. Distinct books should be kept for even the smallest development of this kind, and the results dealt with in the manner of any other profitable or unprofitable investment in the periodical balance-sheets. In cases where the feature is an expensive one, it is highly desirable that estate development should be handled by a separately organised corporation.

The first distinction to be observed, therefore, in commencing the determination of production factors, is between land used for *bona fide* manufacturing purposes, and all other uses. In the latter class will naturally be included land purchased in view of future developments, but not yet in occupation for manufacturing purposes. The acquisition of such land is in the nature of a prudent investment, even though not immediately a productive one, and the capital expenditure, and annual outgoings on it should be separately scheduled and enter only into the balance-sheet and final accounts, not mixed up either with manufacturing or trading matters. It may happen in some cases that land so held in reserve retains its agricultural value, for grazing, market-gardening, or other purposes. In such case any revenue arising out of its letting will be set against the outgoings or treated as revenue arising out of the investment. *Only when such land is actually taken over for the purposes of manufacture does it enter into production factors.*

Though the land production factor contains fewer elements than any other, being made up of interest on capital, and outgoings in the

shape of ground rents, chief rents, mortgage interest, amortisation of leases, rates and taxes—not all of which are necessarily present at one time—it presents certain complications in the settlement of these items which must be discussed in some detail. Most of these complications arise from the different tenures by which land can be acquired and held.

The simplest case may be taken first. In a newly acquired freehold estate, free from mortgage, all of which is devoted to manufacturing purposes, the items which enter into the land factor are (1) interest on capital (2) outgoings in the shape of rates or taxes levied upon the site value. Items which bulk considerably in the case of other property do not enter into the consideration of land values. Land, for example, is not subject to depreciation or obsolescence, it does not require expenditure for maintenance or repair, and entails no particular supervision. Only interest and a very limited class of outgoings are thus involved.

The next least complicated case is where the land is taken under a tenure known by different names in different localities, but essentially consisting of a capital payment for use of the land in perpetuity, but subject to a permanent rent of fixed amount. Where land is held in this way, (1) interest on capital, (2) rent, (3) outgoings form the items reducible to unit value.

In large towns, ordinary leasehold tenure, on which a capital payment is made for the use of the land *for a term of years* subject to a fixed annual payment or "ground rent" is not unusual. This arrangement introduces an altogether new feature into the determination of production factors. We have here (1) interest on capital (2) ground rent (3) amortisation (4) outgoings, as the items to be reckoned with. Amortisation is the provision necessary to meet the wasting character of the property, for as the term of the lease is a limited one (frequently 99 years) and as at the end of that time the land reverts to the original owner, it will be obvious that a fund must be accumulated to replace the capital outlay at the end of the lease. This process is in fact exactly equivalent to depreciation on a machine or building. Though the land itself does not decay, the leaseholder's right to the use of it diminishes in value year by year, as the lease approaches its termination.

Under any of these tenures a further complication may be introduced by the existence of a mortgage, or loan secured on the land. Frequently this is brought into existence, where the purchaser's capital is limited, to enable the acquisition of the land to be completed. In other cases it may be brought about at a later date as a means of

raising money required for some extra demand in the business. This latter case obviously is a matter of finance, not production.

The problem of the acquisition of additional land under exceptional conditions must also be mentioned. In the case of city works that have developed by a gradual process of accretion it sometimes happens that additional space is very difficult to acquire and that considerable sacrifices have to be made to secure it. It may become necessary to acquire an adjoining site covered with buildings, and pull them down for the purpose of clearing the ground and making it suitable for manufacturing purposes. An expensive proceeding of this nature will naturally make the unit-value of that particular area a very high one, and the question of how this increased value is to be dealt with is a very important one. This is treated in detail later on.

Determination of the Land Factor.

We may now turn our attention to the treatment of the land factor and the method of reducing its items to unit value.

It may not be out of place to consider, first of all, what is the precise object we have in view. In ordinary accounting methods all the different expenditures arising out of the holding of land are included in a "burden rate" or "establishment charge" and their individuality is lost to sight. By keeping them separate, and reducing them to unit-value it is obvious that *we are enabled to obtain a clearer picture of the bearing of site value on production*, and the exact object and use of doing this must be clearly grasped if we are to construct our production factors intelligently. It must be remembered, however, that the land factor, although exactly the same in principle as other factors, is the least significant, because it is made up of fewer elements, and is in itself but one of the smaller items of indirect expense.

The object and use of expressing this, and a number of other expenses, as production factors is three-fold. First we gain a clearer idea of the proportion which each such expense bears to other expenses and to total cost; secondly, we are able to observe changes and fluctuations in each such factor separately, and see the effect of new arrangements or new policies and their absolute bearing on the cost of production; thirdly, standardisation is effected and the unit-values of one department can be compared with those of another department, and those of a works in one locality with a works in another locality. In collecting and arranging data regarding land we must seek to express in the factor the permanent and significant facts outstanding from a careful survey of the whole situation.

In the case of a new works erected on a site purchased for the purpose, whatever may be the items that go to make up the factor, it is obvious that they will bear uniformly over the whole area. On whatever tenure it is acquired and whatever the outgoings, no one portion of the ground can be considered as bearing a heavier incidence than any other portion, it being always remembered that unoccupied land does not enter into the production factor, although, of course, bearing its own proportion of the total expenditure. But let us now consider the case of a factory that has made extensions at different times, some of which are more costly than others. How are these additional areas to be dealt with as they come into use? Are they to modify the unit-values already obtaining in the older portion of the works, or are they to bear their own burden, and represent by a higher factor the expensive conditions in which they have been brought into use?

The question is a difficult one and cannot be answered off-hand. We must consider it at some length, as the same principle is involved, and will come up again, with regard to other factors besides land. At the first sight, and if we regard the works as a single unit, it seems absurd not to consider an expensive extension as raising the land factor as a whole. Otherwise, supposing that the same kind of operation were being carried on in both the new part and the old, two different manufacturing costs would result. Though this would be a perfectly true result, and *would represent what was actually taking place,* it would have no practical value in most cases. On the other hand there are circumstances in which it would be both just and wise to allow the higher factors of an extension to represent the actual facts of production. This is so whenever the extension is used for a different class of operation from the remainder of the works. Suppose for example that a firm decides to do its own castings, and for that purpose buys an adjacent site at a much higher price than had been expended on the rest of the land. Very little argument is necessary to demonstrate that the higher factors due to the extension should be confined to that extension, and not permitted to become a means of fictitiously raising the cost of production in departments with which it has nothing to do. Generally speaking, therefore, the principle to be adopted would appear to be that where different conditions give rise to different factors, and there is no pressing, distinct, and practical advantage in consolidating them with the remainder of the works, they should be treated separately. We may put it in even stronger shape and say that ***unless some anomalous and distinctly impracticable result would follow from their being preserved incident on the site to which they belong, they must be so preserved.***

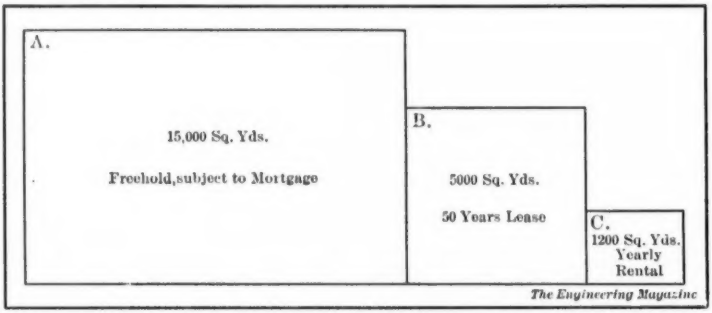


DIAGRAM OF FACTORY LANDS TO BE REDUCED TO UNIT VALUES.

An actual example of the working out of land factors will now be given. The plan (Figure 1) represents a works of which the original portion A was purchased outright. An extension being required, the portion marked B was obtained on a fifty-years lease at a certain ground rent. A third addition being necessary, the piece of ground C was rented—it being found impossible to purchase or lease it—and only light iron buildings of one story being required for the purpose for which it was acquired. We may also assume that part of the purchase price of the freehold portion A was raised by giving a mortgage of $10,000 on it. We assume also that there is no essential difference between the operations carried on in A and B, but that C forms a separate department, which on the principle laid down above is properly liable to bear its own burdens.

The first step will be to ascertain the unit value of each separate area, afterwards combining the incidence on portions A and B and treating them as a single area.

ELEMENTS OF LAND FACTOR FOR PORTION A.—The only complication in this portion is in respect of the mortgage. Two-thirds of the purchase price of the site is assumed to have been raised by this means at 6 per cent. As we assume the rate of interest on the firm's own capital sunk in the investment to be correctly chargeable at 5 per cent, there is a loss of efficiency on the transaction. The question therefore arises as to what is the proper way of dealing with this margin of inefficiency, due it must be assumed to the concern being short of capital, and therefore unable to purchase without having recourse to a mortgage at high interest. In the figures given as an example the difference is trifling, but the *principle* must be determined so as to apply to all cases. We must decide whether the extra expense is properly chargeable to the land factor, or whether it should be considered as a financial matter, pure and simple, and transferred to the profit and

loss account. In other words—are we to consider the annual charges on the land at 5 per cent on the purchase price, or as 6 per cent on two-thirds and 5 per cent on the one-third actually paid for out of capital account?

To solve the problem we must distinguish between the actual and permanent and the accidental circumstances as they affect production. It will be perfectly obvious that the mortgage is a purely accidental handicap, removable at any time, and having no real relation to cost of production. It stands on a totally different footing from the acquisition of an additional site at a high *price,* because the latter is a permanent condition which cannot be remedied. No amount of argument will serve to reduce the incidence of expenditure actually incident on a particular area, but in this case there is a good case for considering that the extra charges involved are not really incident on any particular area. The raising of capital in a particular way has no real connection with the purpose for which that capital is used. Let us consider, for instance, the position of the concern at the commencement of its operations. It had, we may assume, $125,000 of which $120,000 was required for equipment and working capital, leaving only $5,000 available for purchase of land. This seems to connect the shortage definitely with the cost of land, but another way of looking at the facts will dissipate that view. What really was the case was that the concern had prospective liabilities or use for capital, up to a total of $135,000 of which sum it had only $125,000 in hand. It will be seen therefore that it really mortgaged the land to secure an extension of its capital. It cannot really be insisted on that the additional amount so raised had anything to do with the land, as land—in fact, but for convenience, it is quite possible that might have been paid for in full, and the additional capital required obtained by hypothecating some other portion of the assets of the concern.

We may adopt the principle, therefore, that financial arrangements should be carefully distinguished from expenditure which is indissolubly bound up with particular operations. The essential and permanent feature in this case is the acquistion of the land at a certain price. The mortgage must be considered in the light of a subsequent financial deal that has nothing to do with the purposes for which the land was purchased, and as not affecting its annual cost in the slightest degree for any manufacturing purpose.

The elimination of the mortgage from among the items incident on area A leaves us with only two elements of annual cost, namely, interest at 5 per cent on the capital outlay of $15,000, and rates and taxes payable on the site value, which we may assume to be $50.

Adding these two items together we have a total annual expenditure of $800 for the area A.

Elements of Land Factor for Portion B.—The tenure of portion B is not freehold, but leasehold. A payment of $2,500 was made for a fifty-years lease, subject to an annual ground rent of $200. In this case we have to take into account not only the interest on the capital outlay of $2,500, and the ground rent of $200, but we must also provide for the fact that one-fiftieth of the capital disappears each year. That this is so will be manifest from the consideration that at the beginning of the lease it was worth $2,500, while at the end of the fiftieth year it will be worth nothing at all, the leaseholder's rights to the use of the land having expired, and a fresh payment being necessary if a continuance of occupation is desired. In practice, however, the items of interest and amortisation are not taken separately but are consolidated by means of an amortisation table which calculates the two items together, and resolves them into (fifty) annual sums of equal amount. A table of this kind will be found in Messrs. Garcke and Fells' "Factory Accounts." The principle of amortisation may briefly be stated to be this:—each year a sum larger than the annual interest is set aside, sufficient to replace (at compound interest) the original capital at the end of the given term.

To arrive at the total annual expenditure for area B, therefore, we take the combined interest and amortisation, (amounting at 5 per cent to $140) adding to it the ground rent ($200) and the rates and taxes on the site (say $20), making a total annual charge of $360.

Elements of Land Factor for Portion C.—This is the simplest of all, the land being simply rented on annual terms. The items concerned are therefore—rental $150 and taxes $6, giving a total of $156.

Having thus outlined the process of collecting the items that go to make up the totals on which land factors are based, we pass to the reduction of these figures to unit value, and to the indication of how the resulting land factor is used. First of all, however, it will be necessary to consolidate the figures for areas A and B since, as already explained, we can draw no distinction between the manufacturing uses of these two areas.

Consolidation of Annual Values of Sites A and B.

Interest at 5 per cent on $15,000, purchase price of A	$750
Rates and taxes on site value of A	50
Interest at 5 per cent on $2,500 and amortization of 50-years' purchase price of B	140
Ground rent payable on B	200
Rates and taxes on site value of B	20
	$1,160

We thus arrive at a total annual incidence of $1,160 on the combined areas, amounting to (15,000 + 5,000) = 20,000 square yards. Dividing the annual incidence by this we get:—$1,160.00 ÷ 20,000, or 5.8 cents per square yard per annum.

Treating area C in the same manner, we arrive at a unit value of $360.00 ÷ 1,200, or 30 cents per square yard per annum.

It need hardly be mentioned that these unit values, compared with those of sites in the midst of large cities, are very low. Nevertheless, without comparing them with other figures, the above examples will be sufficient to illustrate some of the advantages to be gained by habitually thinking of the indirect factors of production in terms of unit value. A clear recognition of the fact that the unit value of our land is in the neighbourhood of 6 cents per annum for every square yard assists to fix in our minds the relative bearing of land value on production. Asked off-hand, very few manufacturers could tell with any approach to accuracy what was the relative bearing on production of land values in cities and those in country places. In an interesting article on Works Design as a Factor in Manufacturing Economy, contributed to THE ENGINEERING MAGAZINE* by Mr. Henry Hess, the remark is made that "a site in the city itself will generally be too costly for all but light manufacturing." That, probably, in the existing stage of information, is all that can be said on the subject, because attention is never focussed upon site value as a distinct and separate factor of production under present methods of organisation and accounting. In the place of definite unit values only general impressions are current. This applies, of course not merely to the land factor but to many other factors of production equally capable of being regarded separately, and of which the following articles will treat.

Mention was made, above, of a suppositious case in which a plot of land covered with cottages or other buildings was acquired, with a view of demolishing the buildings, clearing the site, and using the cleared land for manufacturing purposes. What is the proper way of regarding the expenditure of demolition?

For production-factor purposes this expenditure must be regarded as adding to the cost of the land. As a matter of valuation this may not be the case, but obviously enough the cost of the demolition must be recovered from the work done on the site, the extra expenditure having been incurred as a preliminary to manufacture. If we look at the matter from another standpoint the justice of this plan will be clear. Instead of purchasing the land and doing its own demolition the firm might have rented the land on condition that it was cleared. In such case the rent charged by the owner would necessarily be

based not only on the site-value but also on the cost of the demolition. For it is evident from the circumstances of the case that if the demand for that particular piece of land is so urgent that it will pay to clear it, then the ultimate value of the site is a monopoly value, as is not infrequently the case in city sites.

Under such circumstances the cost of preparing the land for manufacturing uses must be regarded as adding to its price. In this as in other cases the resulting unit-value will exhibit in its true light, the bearing of the transaction on production.

It would probably be considered advisable in a case of this kind to write down the value of the site in subsequent years. That is to say, that a portion of the excessive cost would be transferred to profit and loss account. Such a transfer would naturally have the effect of reducing the unit-value, which would have to be recast accordingly, as will be understood by all accountants.

In the case of the two areas worked out above, it will be noticed that a difference of 600 per cent exists between the combined areas A-B and the area C. It is true that on these particular figures the higher value is still not a serious handicap on production. This kind of fact is, of course, one of those that it is the object of production factors to bring into prominence, and when the whole series of such factors is built up, variations in the efficiency of production can immediately be traced to their causes—or rather, they will be visible without tracing.

The land factor, however, does not directly form a component of machine rates. It is, in fact, an indirect factor, inasmuch as it has in nearly all circumstances to become merged in another factor, viz. buildings. This does not affect its utility, but assists in locating inefficiency—the advantages of a low land factor may be neutralised by improper types of buildings, and this, if it occur, will be relentlessly shown up. Another peculiarity of the land factor is that it is an "invariable" factor. That is to say, it does not vary with intensity of output at different periods. We shall see later that all factors fall into two groups—variable and invariable, the one group having some relation with the volume of work, the other none at all. This is a distinction that has hitherto escaped emphasis, and no attempt has been made to examine into its actual influence on costs.

We must leave the further consideration of the land factor at this stage, having explained how, under a variety of conditions, the unit value is arrived at. In the next article buildings will be dealt with, and the actual employment of these unit values illustrated.

GAS-ENGINE AND PRODUCER INSTALLATIONS FOR MANUFACTURING PLANTS.

By Percival Robert Moses.

Mr. Moses considers the economy and reliability of the gas-producer and gas-engine installation for the industrial power plant, presenting data of typical costs and formulating conclusions upon points interesting to the factory owner, manager, or superintendent.—THE EDITORS.

THE campaign for the conservation of national resources and the reduction of waste therein has brought in its train more careful investigation of other sources of preventable loss. The public generally, and more particularly that part of the public whose interests are allied with manufacturing, such as engineers and manufacturers, have awakened to the fact that every pound of coal burned unnecessarily and every heat unit wasted is wasted irretrievably.

It is one of the great values of hard times that people begin to investigate more carefully the methods and materials they employ, and begin to question the necessity of the thousand-and-one wastes their investigations develop. One of the most striking of these wastes is the small percentage of the energy contained in a pound of coal which finally performs useful work, either in the shape of power for driving machinery or in the form of light.

In previous articles, the importance of reducing the waste in steam-engine operation by utilizing the exhaust steam as fully as possible has been pointed out, and where the exhaust steam can be used fully the steam engine is nearly as perfect a piece of apparatus as can be devised. Unfortunately, with the exception of such instances as sugar industries, salt manufacture, dyeing or bleaching establishments, and similar classes of manufacturing, the uses for exhaust steam (except to heat the buildings) are extremely limited, and, in fact, in most large manufacturing establishments, outside of the most severe part of the heating season, the amount of exhaust steam available from the power plant is far in excess of the amount required for heating; so much so, that in large mills it becomes more economical to operate the main power plant condensing, wasting the heat contained in the condensed steam, in order to get the better average efficiency all the year around from the engine operation.

In the great majority of manufacturing establishments, the cost of heating is not of major importance. Manufacturing plants requiring 1,000 or more horse power of power-plant machinery, will probably need not more than 75 to 80 horse power for heating. For example, a plant consisting of two buildings 400 by 50 feet by 40 feet high, two buildings 300 by 75 feet by 30 feet high and four buildings 100 by 50 feet, might easily require 1,000 horse power for heavy work such as the manufacture of castings or fittings, and such a combination of buildings with the usual quantity of storage space would certainly not require over 100 horse power for heating.

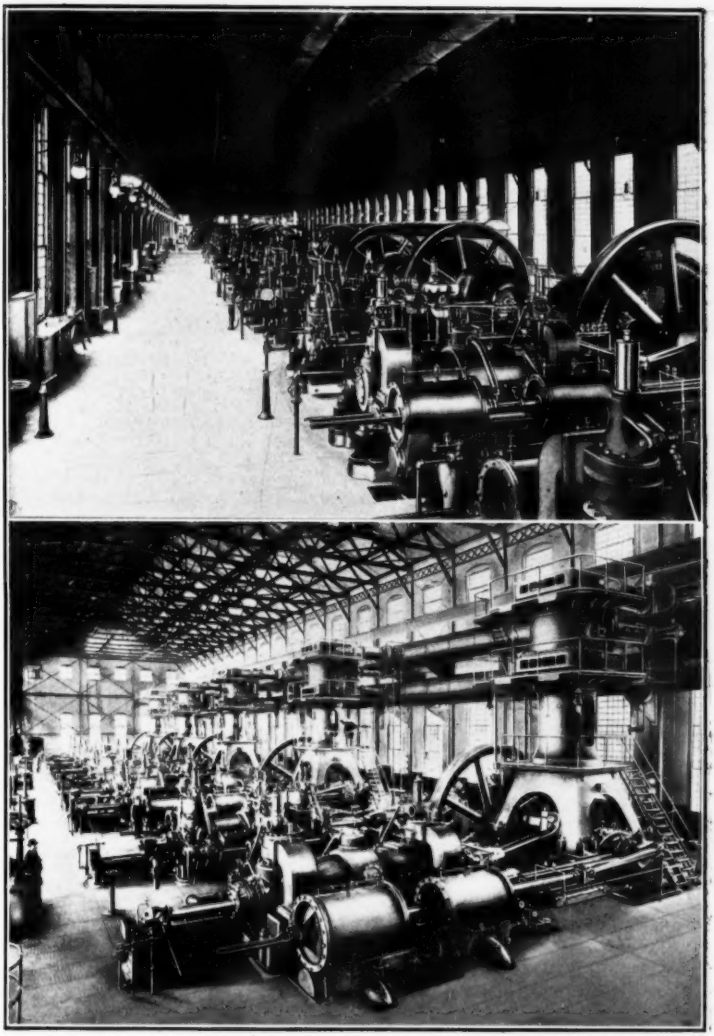
With such an installation it becomes evident that the ordinary non-condensing steam engine is only economical in so far as its exhaust can be utilized. Hence, if any non-condensing steam engines are to be installed they should be limited to the size required to supply the needed exhaust steam. All power in addition to this quantity should be furnished by some higher-efficiency apparatus, and the choice becomes one between condensing steam engine or turbine, the producer-gas engine, and the oil engine.

In THE ENGINEERING MAGAZINE for March, 1908*, a table was printed, showing the comparative cost of producing 124,000 kilowatt hours per year from a plant of from 70 to 90 kilowatts, the average load for ten hours being 40 kilowatts, the cost being figured with and without allowance for heating of a building 80 by 125 by 70 feet high, under New York City conditions.

In the type of manufacturing building now being considered the question of heating disappears and the matter becomes merely one of a comparison of costs in manufacturing power. In the table previously published for the "small factory," comparison was made between a non-condensing steam plant and a gas engine and oil engine. The figures given in this former table do not, therefore, apply to large manufacturing establishments, and particularly not that portion of the power plant that we are now considering.

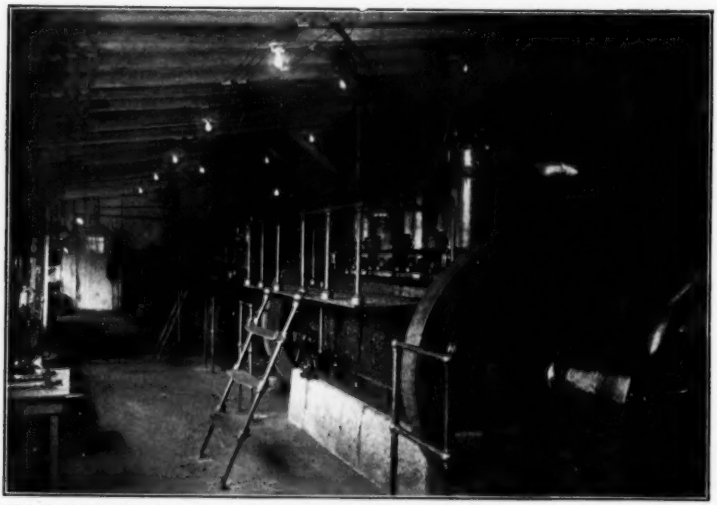
In order to obtain a definite idea as to comparative cost, an establishment is assumed consisting of buildings spread over several acres of ground, located close to water available for condensing purposes or other purposes. It is assumed that the heating requirements and the other uses of low-temperature heat will not amount to more than 15 per cent of the power required for manufacturing purposes. All the machinery is electrically driven, either by group drive or individual drive. The character of the work is similar to that of a large foundry or machine shop—i. e., a heavy, more or less fluctuating.

*Power Equipment for the Small Factory. P. R. Moses, pp. 902, 903.



KOERTING GAS-ENGINE INSTALLATIONS, LACKAWANNA STEEL COMPANY.

Above, 8,000 horse power of De La Vergne gas engines (Koerting patents) in 1,000 horse power two-cycle single-cylinder units, direct-connected to d. c. and a. c. generators. Below, sixteen 2,000 horse power two-cycle single-cylinder engines direct-connected to blowing engines. All operating on natural gas. De La Vergne Machine Co.



BRUCE-MACBETH GAS ENGINES, POWER PLANT OF WILLARD STORAGE-BATTERY CO., CLEVELAND, O.

One four-cylinder 135 horse-power engine and two two-cylinder 80 horse-power units. Operated continuously on 24-hour service. Bruce-Macbeth Engine Co.

load. The plant operates ten hours a day steadily throughout the year, with the exception of Sundays and holidays, and it is necessary to provide for night work, but for only a small portion of the plant.

The number of kilowatt hours delivered per year is 1,000,000. 750 horse power of motors are installed and the lighting, using tungsten and other efficiency lights, amounts to 50 kilowatts in addition to the power load. The maximum load is figured at 400 kilowatts and the average load, for a ten-hour period, at 300 kilowatts.

The cost of the several types of plants would be, exclusive of the power house:

Steam equipment	$100.00	per kilowatt
Gas engine and producer equipment	115.00	" "
Oil engine equipment	132.00	" "

The cost is subdivided as follows:

STEAM:

Compound condensing steam engine	$25.00	per kilowatt
Boilers	20.00	" "
Steam piping and condensers	20.00	" "
Smoke stack and breeching	$4.00 to 5.00	" "
Auxiliary apparatus (feed-water heater, grease extractor, steam separator)	3.00	" "

If an economizer were to be installed $6.00 per kilowatt should be added. This would depend, of course, upon the cost of coal and the extent to which economizing might be resorted to.

GAS:

Gas engine	$70.00	per	kilowatt
Producer equipment, including scrubber, etc	15.00	"	"
Gas piping, exhaust heater, engine conns	$10.00 to 15.00	"	"

OIL:

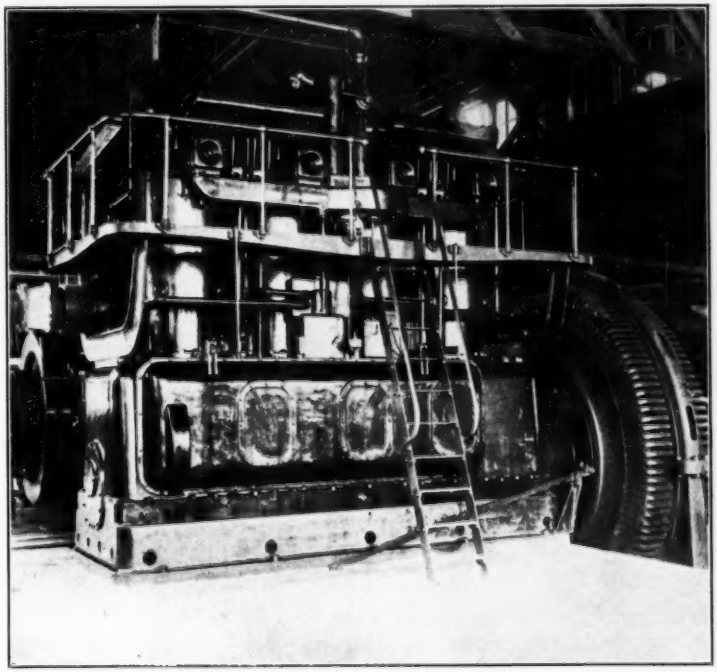
Oil engine	$100.00	per	kilowatt
Exhaust heater piping, etc	$7.00 to 10.00	"	"

ELECTRIC (to be added to separate items in each type of plant):

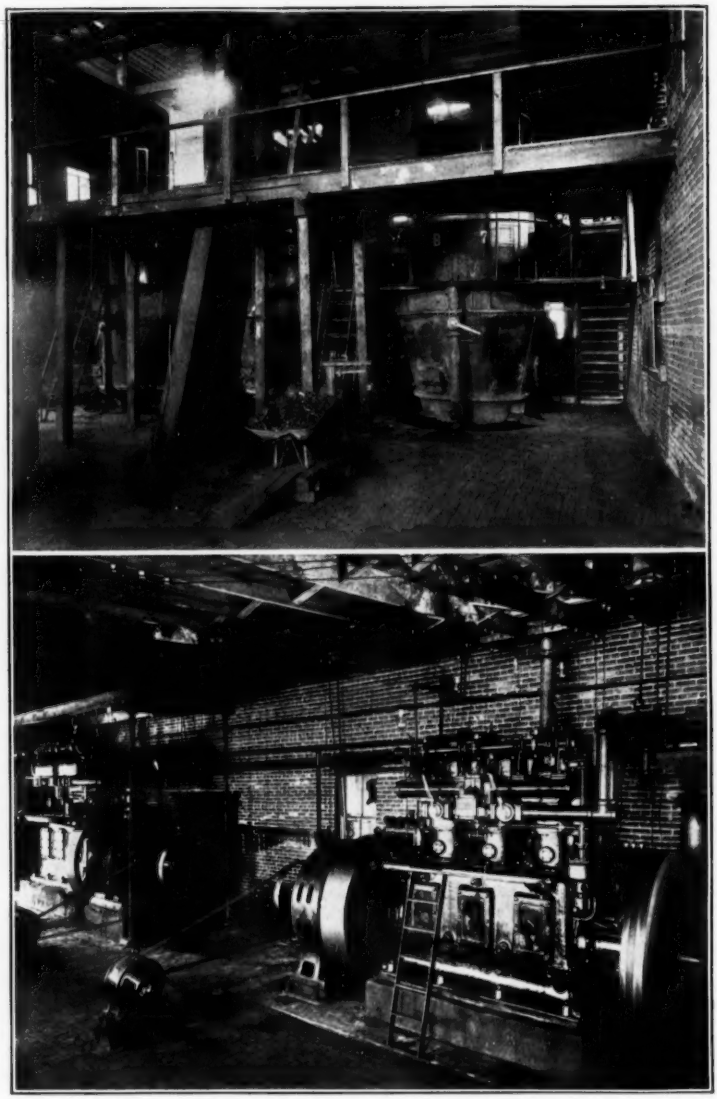
Dynamos	$15.00 to $20.00	per	kilowatt
Switchboard	5.00 to 10.00	"	"
Wiring connections	5.00 to 10.00	"	"

POWER HOUSE:

The cost of the power house would vary from $10.00 to $20.00 per kilowatt



RATHBUN GAS ENGINE, TULSA CORPORATION, TULSA, OKLAHOMA.
Operates on natural gas; 300 horse-power unit direct-connected to 250-kilowatt generator.
Rathbun-Jones Engineering Co.



WESTINGHOUSE GAS PRODUCERS AND ENGINES, POWER PLANT OF THE WESTERN CHEMICAL MANUFACTURING CO., DENVER, COL.

Three pressure producers, each of 175 horse-power capacity, burning bituminous lignite from northern Colorado. Two vertical single-acting Westinghouse producer-gas engines, total capacity 330 horse power. Westinghouse Machine Co.

The prices are given per kilowatt of dynamo capacity, because the ratings of gas engines and turbines or steam engines are not on the same basis. The steam engine and steam turbine have overload capacities of 50 per cent above their rated capacity, while the gas engine is rated at within 10 per cent of full capacity, and the same is true of the oil engine. Hence, a 300-horse-power steam engine will be able to generate the full capacity of a 200-kilowatt dynamo, but a gas engine of the same maximum output for peak-load period should be rated at at least 400 horse power. The plant under consideration, allowing for one spare unit, for maximum load of 400 kilowatts, could be made up of either four 135-kilowatt sets or three 200-kilowatt sets.

DU BOIS PRODUCER AND GAS-ENGINE INSTALLATION FOR PHILADELPHIA GEAR WORKS.
Du Bois Iron Works.

For gas-engine or oil-engine plants, four sets would prove most economical, as the cost per kilowatt does not decrease as the sizes grow larger. For a steam plant, division into three or even two units would be more advisable.

The total cost of the plant would be about as follows, the steam plant being figured without superheaters or economizers:

Gas engine and producer	$70,000
Oil engine	78,000
Steam engine	60,000

The cost of operation of the three different types—i e., the cost of fuel, labor, oil and repairs—would be:

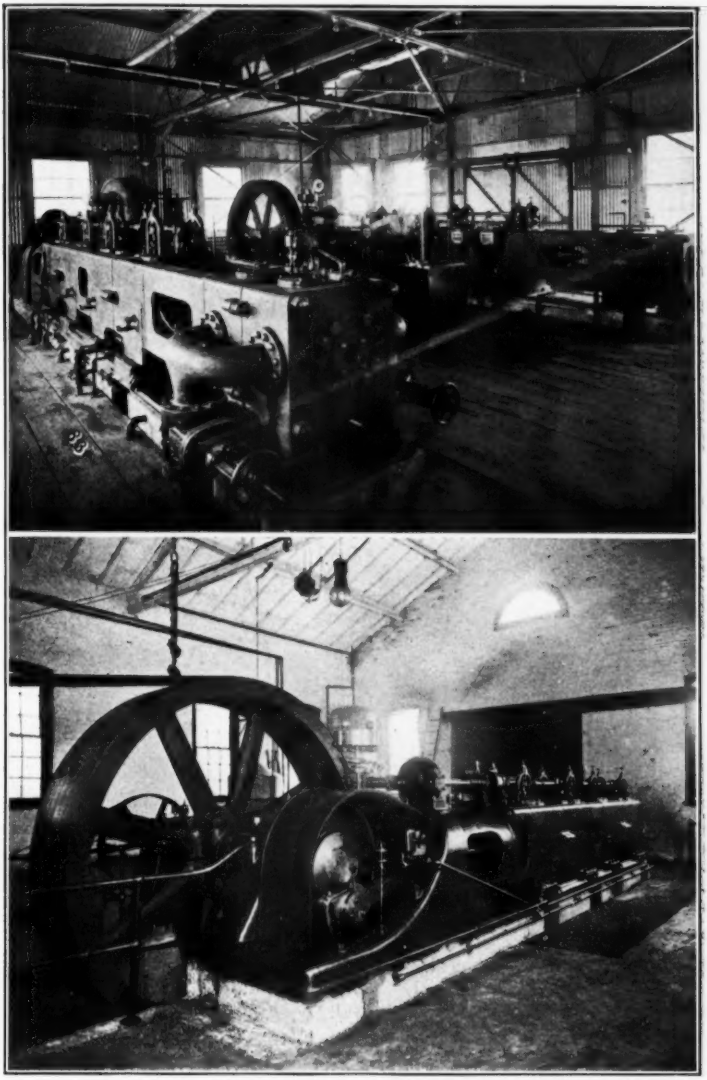
GAS-ENGINE AND GAS-PRODUCER PLANT:	
Coal, including stand-by charges, 1,000 tons at $2.50	$2,500
Labor, one machinst, one helper and one producer man	2,500
Oil	400
Repairs, averaged for a number of years	750
Total	$6,150
Fixed charges, 10 per cent of installation cost	7,000
Total annual cost	$13,150
OIL-ENGINE EQUIPMENT:	
Oil at 3 cents per gal. (for fuel), 7 kilowatt hours per gal.	$4,300
Labor, one machinist, one helper	1,800
Oil (for lubrication)	600
Repairs, averaged through a number of years	900
Total	$7,600
Fixed charges, 10 per cent of installation cost	7,800
Total annual cost	$15,400
STEAM-ENGINE PLANT:	
Coal, 5 pounds per kilowatt hour plus 20 per cent for stand-by losses 3,000 tons at $2.00	$6,000
Labor, engineer, assistant and fireman	2,670
Oil	300
Repairs, averaged through a number of years	1,000
Total	$9,970
Fixed charges, 10 per cent of installation cost	6,000
Total annual cost	$15,970

None of these figures includes any coal required for other purposes, and in making comparison this need not be considered unless the comparison is between a non-condensing engine and any other type of plant.

The comparative cost per kilowatt would be as follows:

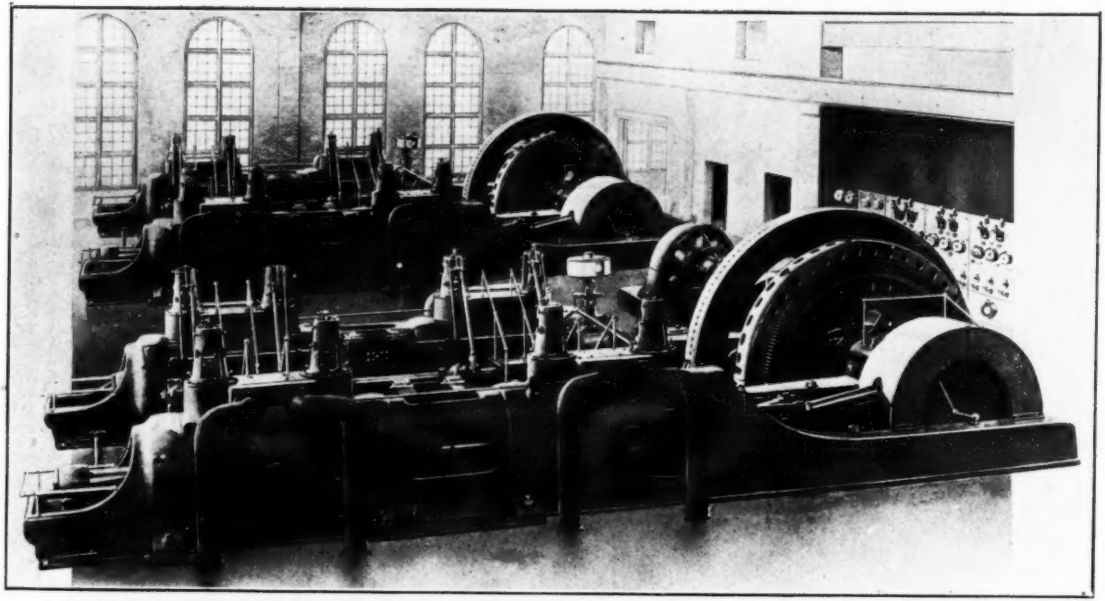
Gas engine and gas producer	1.315 cents
Oil engine plant	1.54 "
Steam engine plant	1.59 "

It is evident from these figures that the gas producer and gas engine plant is about 18 per cent more efficient than the other plants. Given equal reliability and perfection of operating results, this type of plant should have the preference, because, co-incident with the reduction in cost of operation go reduction in the quantity of material



RIVERSIDE GAS ENGINES INSTALLED FOR VARIOUS SERVICES.

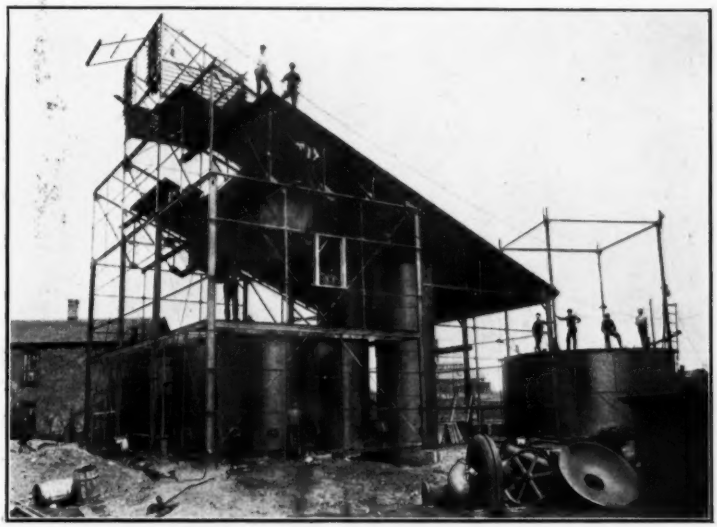
Above, two 250 horse-power double-acting tandem gas engines, piston-rod coupled to gas pumps, Neodesha station of Kansas Natural-Gas Co. Below, 300 horse-power unit belted to alternator, Watson-Stillman Co., Aldene, N. J. Was used in trying out a new make of producer, and in spite of constantly changing heat value of gas and of violent dust rushes, is said to have run a year without opening up a cylinder or taking out a valve. Riverside Engine Co.



ALLIS-CHALMERS GAS ENGINES AND GENERATORS, 1,250-KILOWATT CAPACITY, MILWAUKEE NORTHERN RAILWAY.

to be handled, such as fuel and ashes, the absolute doing away with smoke, greater cleanliness around the plant, no steam gaskets to blow out or packing to leak, no boiler linings to be repaired—as the producer lining lasts indefinitely, with proper care—etc.

Gas engines and gas producers are now reliable pieces of apparatus. Such plants as those of R. D. Wood & Co., and the Baldwin Locomotive Co., depend wholly upon either gas engines or oil engines, and in the plant of the Trenton Iron Works, where there is a gas engine of the Allis-Chalmers make and a steam engine made by McIntosh & Seymour, the gas engine is operating at least as reliably as the steam engine. In fact, in a large number of plants, investigated personally by me, no serious trouble has been experienced in the operation of the gas engine, and there seems to be no question but that if properly operated and cared for, the gas engine operating on producer gas is equally as reliable and dependable as a steam engine.

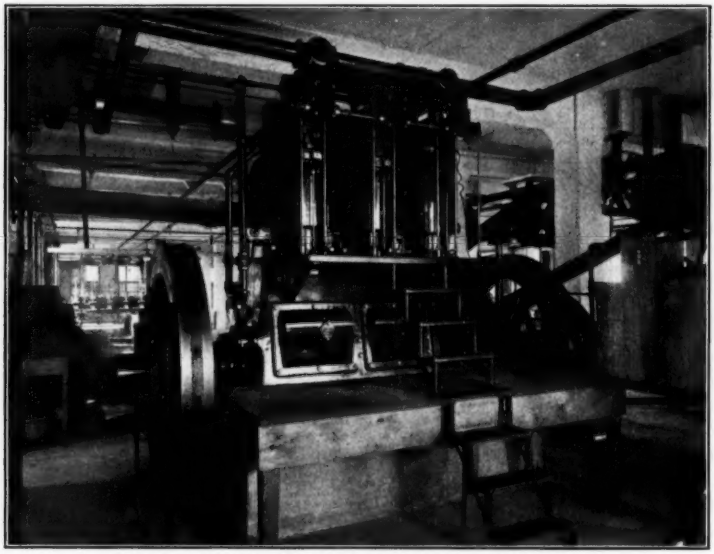


PARTLY ERECTED PRESSURE PRODUCER OF 900 HORSE-POWER CAPACITY, FOR ELECTRIC LIGHT & POWER SERVICE.
R. D. Wood & Co.

As between the producer and the boiler plant, there is no comparison. In some producer plants visited, the fire had not been out since the producer was installed a number of years ago. There are no high pressures to contend with, no feed pipes to pit out, no gaskets to blow out, and the firing becomes no longer a matter of hard work but one of skill and regularity. In a smaller plant, as one owner remarked,

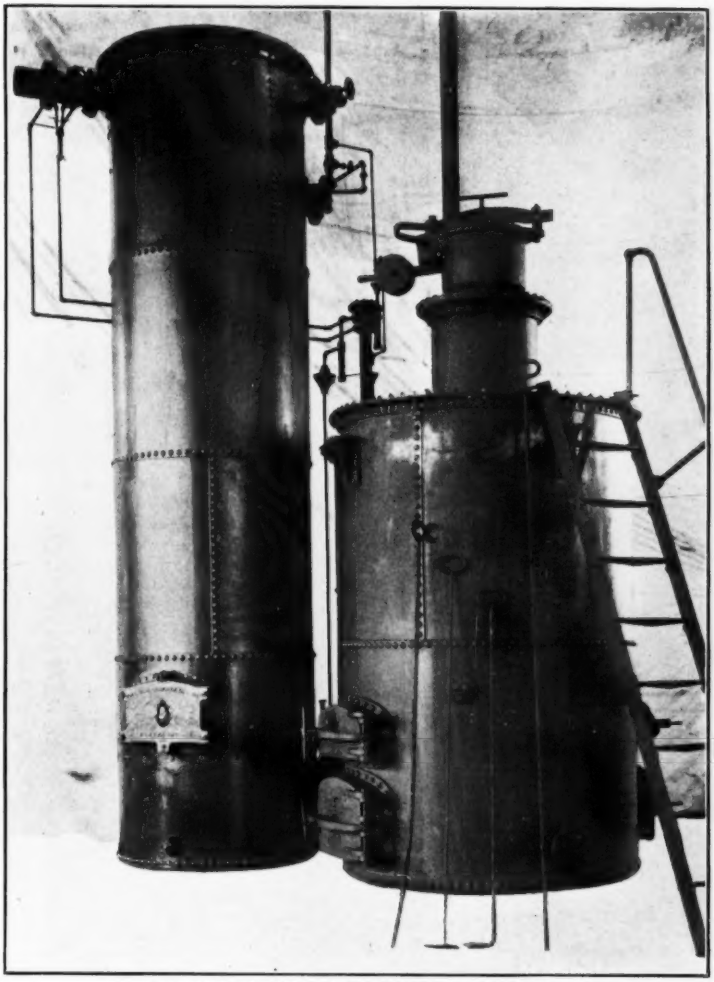
firing the producer was "like pouring coal onto a grate," the firing consisting of dumping a scuttle of coal into a hopper.

The statistics of some engine-insurance companies give the following figures as to the comparative reliability of a steam-engine plant and a gas engine plant: Breakdowns, steam engines 1 in 8.1; gas and oil engines, 1 in 12.4 It is fair to state that as gas-engine plants become more common the figures will more nearly approach each other, as under present conditions the grade of engineers employed by gas-engine plants is equal to the highest grade of engineers, while the grade of engineers employed in a great many steam plants is not up to such a high standard.



FOOS GAS ENGINE, STANDARD OPTICAL CO., GENEVA, N. Y.
An engine of 100 horse power operating on anthracite producer gas and driving a part of the factory by rope transmission. Foos Gas Engine Co.

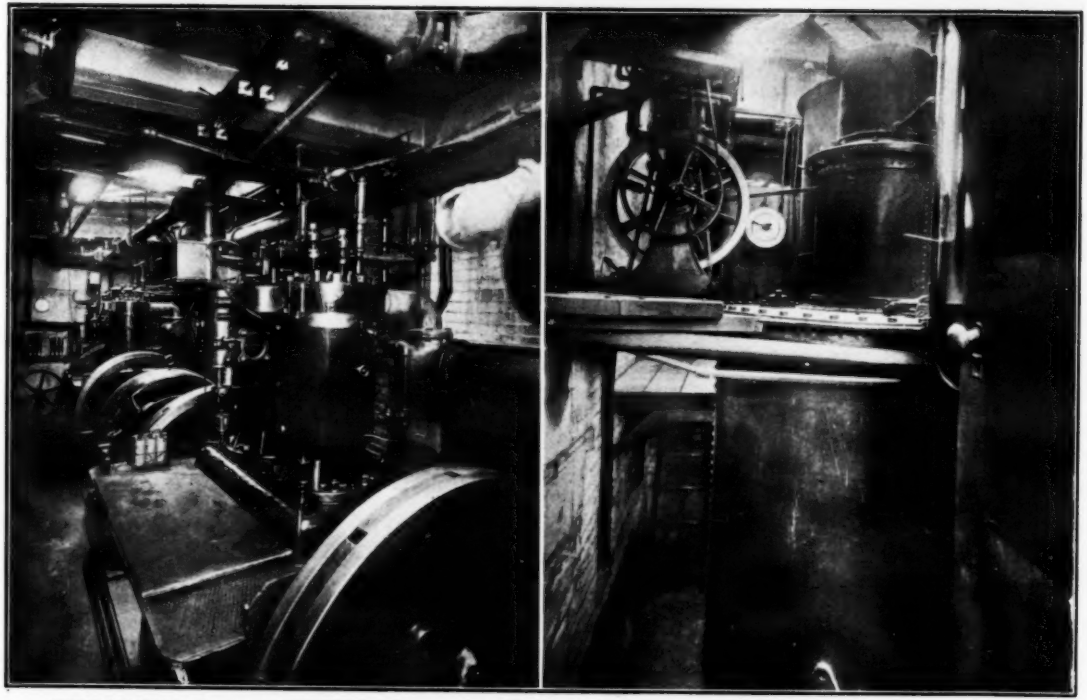
Although the gas-engine and gas-producer apparatus is of comparatively recent growth in the United States, there have already developed several types of apparatus. In producers, we have the "pressure" and the "suction" type, the "bituminous" up-and-down draft type and the alternate air and water gas type. Each one of these types has several modifications, as for example, in the suction type of producer, R. D. Wood & Co. place the vaporizer on top; the Smith Gas Power Co., Lexington, Ohio, place the vaporizer on the inlet, the Gas Machinery Co. place the vaporizer on the outlet, and the Gas Power



WILE GAS PRODUCER, 125 HORSE-POWER CAPACITY.
Gas Machinery Co.

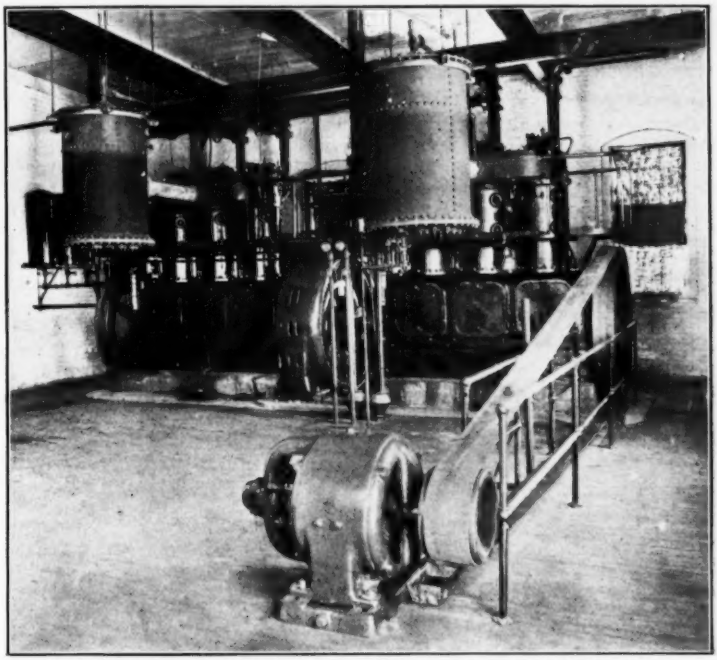
Co. (Tait process) do away with the vaporizer entirely, using the engine gases instead of steam. With the pressure type of producer, steam blowers or fan blowers are used, the latter being more efficient and also more costly.

With the bituminous producer, each designer has his own special way of avoiding troubles with clinkers and arching of the fire bed, one well-known engineer employing the method of revolving the



BRUCE-MACBETH ENGINES AND WILE PRODUCER PLANT, INSTALLED FOR J. P. EUSTIS MANUFACTURING CO., BOSTON.
Two vertical multi-cylinder engines of 55 horse power each, direct-connected to 80-kilowatt generator. An illustration of effective installation in a very limited space. Bruce-Macbeth Engine Co.

walls of the producer, keeping the grates stationary, to get over the trouble. There are also producers designed especially for gasifying the very low grades of fuel—such as coke breeze—the main requirement being a small depth of fuel bed.



RATHBUN-JONES GAS-ENGINE PLANT, DALTON POWER CO., DALTON, MASS.
Six-cylinder 300 horse power. Rathbun-Jones Engineering Co.

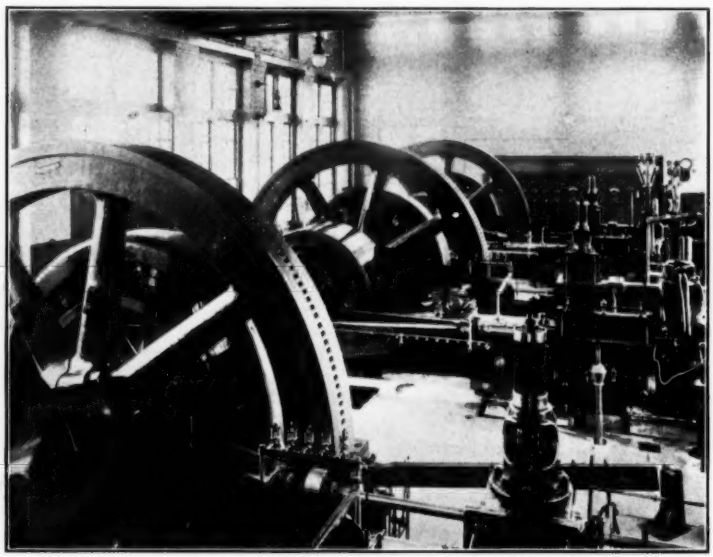
Gas engines are equally diverse in their characteristics, and in making comparisons very careful analysis is required. Recently bids were obtained on a 200-kilowatt plant, and the following different types were bid on:—

Four-cylinder single-acting
Four-clinder double-acting
Three-cylinder single-acting vertical
Two-cylinder tandem horizontal double acting
Two-cylinder single-acting horizontal

Almost all the bidders used the magneto system, with a storage battery as a reserve, for ignition, and a centrifugal type of governor. Only one bidder used a Wright governor— i. e., a shaft type. All

figured on a four-cycle type of engine. The amount of water cooling varied from one bidder, who provided for cooling the piston, piston rod, valve stem, valve, and all parts of the cylinder and cylinder head, to another bidder who figured on cooling the cylinder and cylinder head only.

Strangely enough all these diverse forms of apparatus seem to give satisfaction. This can be accounted for largely by the fact that producer gas is a slow-burning gas; hence, there is not the severe



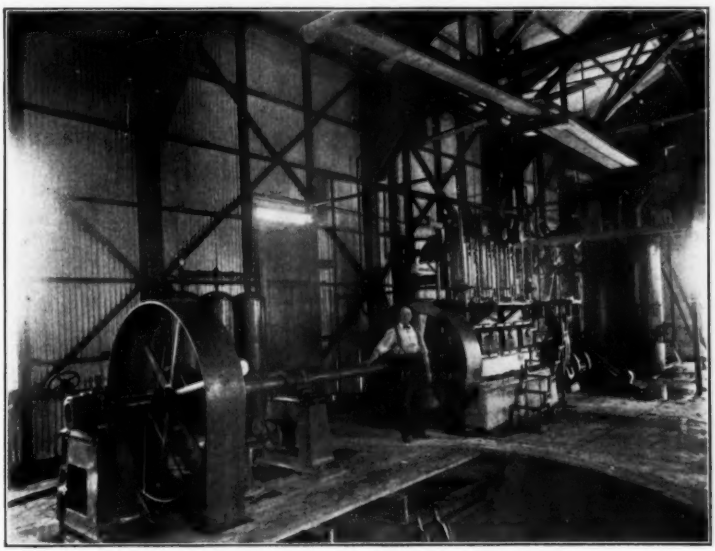
KOERTING GAS ENGINE, DRIVING CROCKER-WHEELER GENERATORS, MEDFORD STATION, BOSTON ELEVATED R. R.
Three 325-kilowatt 550-volt machines; gas engines installed by De La Vergne Machine Co.

shock that there is with natural or illuminating gas. The operation becomes more like the operation of the steam engine, and as the combustion is slower the maximum temperature must also be less. Adjustments are also easier because the volume of gas handled is greater.

It would seem that unless a radical improvement be made in the results obtainable from the steam engine, it must inevitably be replaced by the gas engine and producer in a manufacturing plant where exhaust steam cannot be largely utilized.

While it is true that gas-engine and gas-producer plants are entirely reliable if operated properly and properly designed, it is also true that failure to fully appreciate several factors has led to failure in many instances.

One of the principal causes of trouble met with is the failure to provide for continuous operation. In the suction type of plant, where the air and steam are drawn through the fuel by the action of the gas engine, it is found in many types of installation that during the period of cleaning out the ashes, while the ash-pit doors are open, the quality of the gas derived from the producer becomes very poor. This arises from the fact that more air and less steam are drawn through the bed of the fire, causing a higher temperature of the fuel bed and a more complete combustion, hence, more carbon dioxide or completely consumed coal. Where the doors are opened for any length of time, unless this contingency is provided for, the quality of the gas falls to such an extent that difficulty is experienced in maintaining the speed of the engine. This corresponds somewhat to the drop in steam pressure when fires are cleaned with only one boiler in the plant.



FOOS GAS-ENGINE INSTALLATION, CITY PUMPING PLANT, BROWNWOOD, TEXAS. Uses Texas lignite producer gas, and drives a centrifugal pump; 100 horse power. Foos Gas Engine Co.

A second difficulty arises through lack of automatic regulation of the water supplied to the vaporizer of the producer plant. As producer gas is made, generally, by drawing a mixture of steam and air through the fuel bed, it becomes necessary to adjust the proportions of air and steam to the different conditions of load. There are a number of ingenious devices for accomplishing this result, and some

of them work very perfectly, but some such device is a necessity for efficient economic operation if the plant is to be operated at or near its full load. Of course, if the plant is to be operated at far below its normal rating, almost any producer and any system will work.

A third cause of trouble has been the presence of sulphuric acid leading to the pitting out of exhaust valves and cylinders and exhaust pipe. This trouble arises if the water is not properly separated from the gas or if the exhaust is discharged through water. Mr. Godfrey Tait, by his patented monoxide producer, gets over the trouble with sulphuric acid and also the trouble as to varying the quantity of steam, by doing away entirely with the use of steam and using instead exhaust gases from the engine as a cooling medium for the fuel bed.

The gas formed by the combination of the carbonic dioxide with the carbon of the coal in the producer is a gas lower in value by approximately 20 per cent than the gas delivered by the steam system; hence, a greater quantity of it is required to develop a given horse power in the engine. This seems to be its sole disadvantage, to be balanced against the advantage of low hydrogen content of the gas and, therefore, low sulphuric-acid content.

The losses in connection with the design and operation of gas engine and gas producer equipment are mainly as follows:

The loss from the producer itself by radiation.

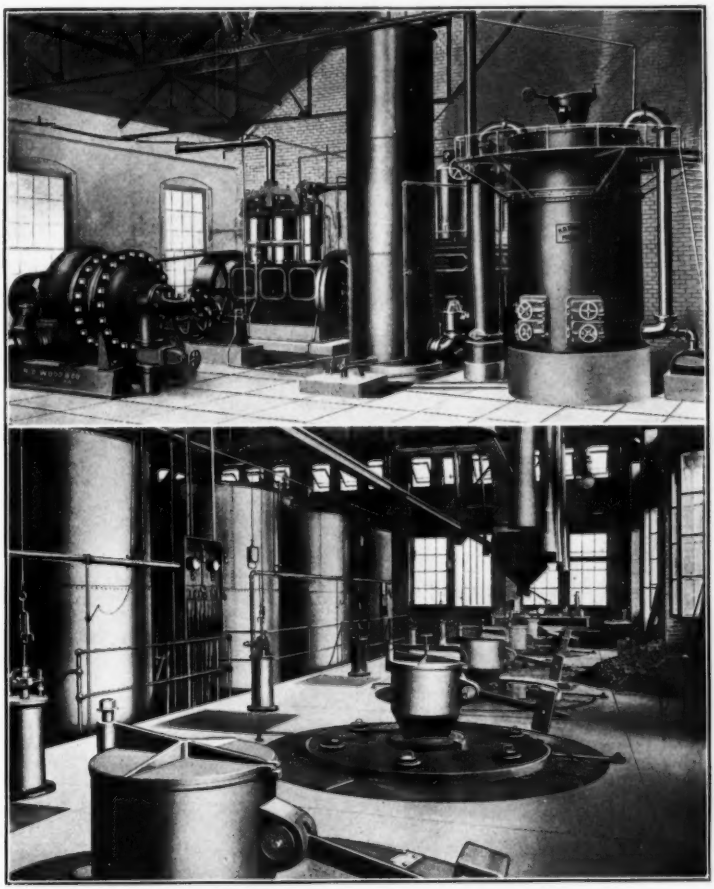
The loss of heat carried by the gas from the producer to the scrubber.

The loss of heat carried away by the water used to cool the jacket, valves, and other parts of the engine.

The heat carried away by the exhaust gases from the engine.

The first loss, due to radiation from the producer, may be minimized by heavy brick lining and magnesia and other insulating materials placed between the lining and the shell or outside of the shell, such as steam-pipe covering or boiler covering.

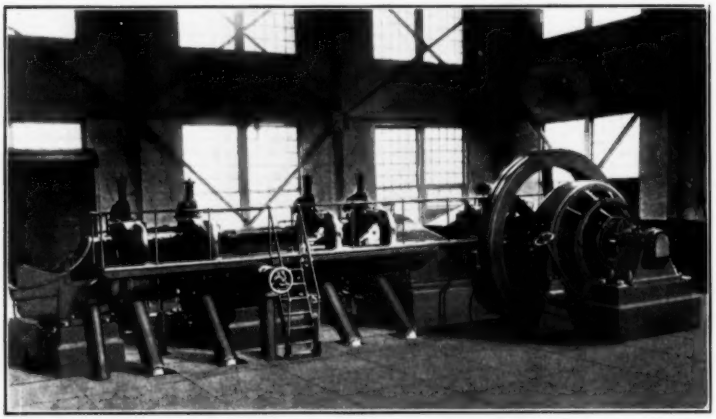
In most producer plants now, the "sensible" heat, as it is called, of the gas going from the producer to the scrubber is used to vaporize water, this vapor being utilized in the producer to form gas. In some forms of producers, this vaporizer is located on top of the producer itself; in others, on the line leading from the producer to the scrubber. In this way, the gas coming from the producer is cooled down from the temperature of, perhaps, 1,000 degrees F. to the temperature of 300 degrees F. In connection with the saving of the heat carried away by the jacket water of the engine, difficulty arises from the large quantity of water used by the engine for cooling purposes.



ABOVE, SUCTION GAS PRODUCER—WITH 150 HORSE-POWER THREE-CYLINDER GAS ENGINE DRIVING 8-INCH THREE-STAGE CENTRIFUGAL PUMP. BELOW, WORKING PLATFORM, SCRUBBERS, ETC., FOR AN 1,800 HORSE-POWER PRODUCER PLANT.
R. D. Wood & Co.

Nearly 25 per cent of the available heat from the fuel is carried away by the jacket water, and if this can be used for hot water or for heating the building the efficiency of the gas-engine plant is just so much increased.

In a plant recently designed by me, the jacket water is to be led to a so-called exhaust vaporizer where part of it will be turned into



WESTINGHOUSE GAS ENGINE, AMERICAN LOCOMOTIVE COMPANY'S PLANT, RICHMOND, VA.

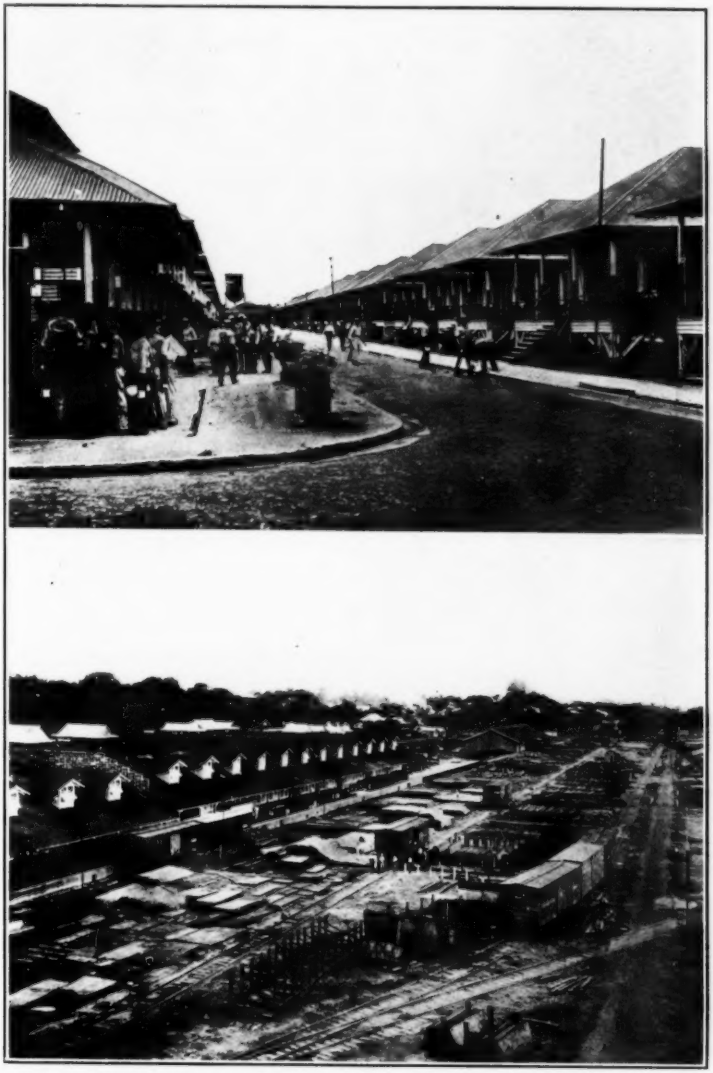
Tandem double-acting unit of 500 horse power operating on producer gas. Westinghouse Machine Co.

steam by the exhaust gases from the engine, the vaporizer being practically a boiler inserted on the exhaust line from the engine to outdoors. By this means, it is hoped to utilize not only the heat in the jacket water but the heat of the exhaust gases. The steam derived from this vaporizer will be used to operate a pump and engine, moulding machines, etc., and in winter it will be discharged into the heating system.

In the plant of the Ramapo Iron Works, the exhaust gases are discharged through an air economizer; the heated air being blown through a long duct to the plant of the iron works for heating purposes. Where such means are used for saving the waste heat, the gas engine equipment becomes a very highly efficient piece of mechanism, just as the steam engine becomes a high-efficiency apparatus when its exhaust is used, and I see no reason to doubt that these wastes will be saved as indicated.

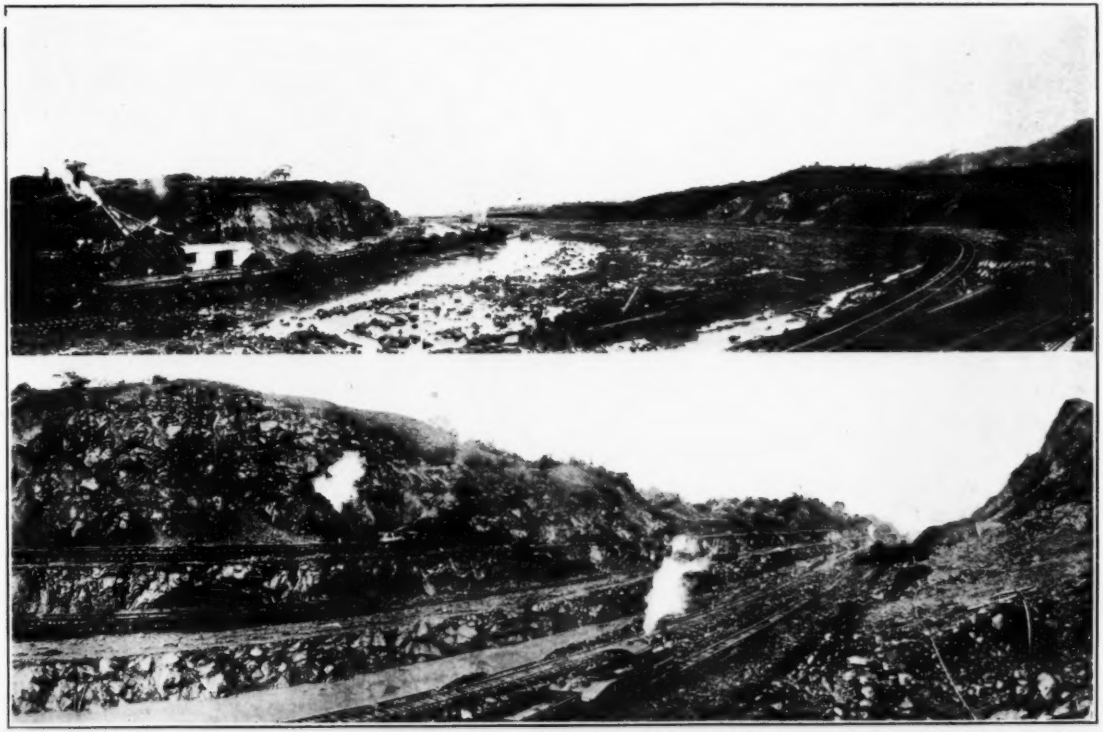
RECENT PHOTOGRAPHS OF THE PANAMA CANAL.

WITH ABSTRACT OF THE ANNUAL REPORT ON PAGE 425.



THE LABOR BARRACKS AT CRISTOBAL AND THE MATERIAL YARD AT MOUNT HOPE.

THE LOWER END OF THE GATUN SPILLWAY FLOOR AND WALL, AND THE GATUN LOCKS FROM THE EAST, SHOWING ANCHORAGE AND CONSTRUCTION PLANT.



ABOVE, THE EXCAVATION THROUGH "POINT 2," IN THE LAKE SECTION OF THE CANAL. BELOW, THE CULEBRA CUT, LOOKING ACROSS AND SOUTH FROM BAS OBISPO. THE VIEWS SHOW THE CONDITION OF WORK IN MAY OF THIS YEAR.

ENGINEERING ASPECTS OF LARGE POWER CONTRACTS.

By Howard S. Knowlton.

Mr. Knowlton presents here the first of two articles discussing the relations between the power company and the power consumer in a new manner and from a new point of view. The purpose is to treat the manufacture and sale of power according to the principles that have been established in the construction and manufacture of engineering products generally. The proposition is analyzed into its elements and sub-divided into its details, each feature being clearly defined and rules given for its successful management.—THE EDITORS.

THE development and extension of electric-power transmission systems create many new problems and conditions in the territories which they serve. Foremost among these are the engineering considerations which relate to the design and construction of the physical plant, including preliminary investigations of the technical problems of water flowage and conservation, the establishment of generating and distributing facilities, and the survey of the commercial situation within a profitable radius of the power-plant installations. Of equal importance are the legal questions to be determined, including the securing of water rights, real-estate titles, franchises, and rights of way. The treatment of these matters has been considered at length within recent years by writers upon engineering topics, and such questions are of permanent interest when discussed in relation to specific combinations of physical and commercial conditions. In the larger fields of power supply they involve matters of wide scope, and need to be dealt with by all parties concerned in a much broader way than in cases where the sale of power is simply a local enterprise.

After a power system is established upon sound engineering foundations, and preferably before the delivery of energy has begun upon a large scale, it becomes necessary to determine the conditions under which the company's revenue shall be gained, and here the engineer and the legal adviser need to work hand in hand to secure the best results. The conditions differ so often and so widely from those encountered in the purchase of power from a local plant that it appears worth while in the following paragraphs to review in a general way

the engineering aspects of large electric-power contracts, omitting the legal structure for the sake of simplicity and confining the matter presented to the practical engineering considerations which must be taken in hand and turned over to the legal advisers of the enterprise for proper expression. A keen appreciation of these points is quite as valuable to the purchaser of power as to the company which sells the service. Whether the purchaser be a municipality, an electric-railway system, a central station, or an industrial plant, it is most important to realize that the supply of electrical energy on a large scale over perhaps many hundreds of square miles and in scores of communities is not the affair of a neighborhood, or a transaction between intimate personal acquaintances. Provincialism has no economic place in the sale of power under such conditions. According to the special conditions of each instance will the power agreement resorted to be simple or complex, but it should properly harmonize with the policy of the transmission company throughout its entire area of distribution and therefore leave no opening for charges of discriminatory rates or unprofitable service, while it is yet sufficiently flexible to meet the needs of each local consumer. It is needless to state that no single contract form could be presented here which would meet the requirements of all situations, and nothing of the sort will be attempted. At the same time an outline of certain engineering features of importance in several recent large power contracts may be given.

In general the sale of power on a large scale requires an agreement covering all matters that may come up in connection with five principal divisions of the initial transactions and the performance of the contract. These five divisions or branches, placed in the chronological order in which they are likely to present themselves in the actual negotiations, are:

1.—Definition of the Service to Be Rendered.
2.—Payment for the Service.
3.—Establishment of the Service.
4.—Operation of the Service.
5.—General Considerations.

Under these heads in concrete cases there will be numerous ramifications and at times overlapping of sub-headings. There is of course room for differences in opinion as to the desirable classification of points. In the following outline the points named are all drawn from recent practice.

1.—Definition of Service.

a. Kind of current to be supplied.
b. Points of delivery and recipients.
c. Times of delivery.
d. Amount of service to be rendered.
e. Expansion and contraction of service rendered.
f. Quality of service to be supplied.
g. Utilization of service by recipients.
h. Preferred customers.

2.—Payment for Service.

a. Prices for the service to be rendered, including extra demands.
b. Measurements of the service.
c. Tests of measuring equipment.
d. Billing and collections.
e. Penalties for non-payment for service.
f. Rebates for service impaired or not rendered.

3.—Establishment of Service.

a. Physical limits of responsibility.
b. Franchises, permits, rights of way, taxable property.
c. Design and construction for transmission and distribution, permanent and temporary.
d. Allowance for existing and future facilities utilized under c.
e. Apportionment of cost and approval of changes in service and equipment.

4.—Operation of Service.

a. Maintenance of equipment, repairs, renewals, depreciation.
b. Labor requirements.
c. Supplies.
d. Accidents and emergencies.
e. Auxiliary supplies of service, co-operation, reciprocal contracts.

5.—General Considerations.

a. Termination of agreement.
b. Renewal of agreement.
c. Competition.
d. Modifications or review of agreement after stated terms.
e. Arbitration.

Detailed Engineering Features.

1.—Definition of Service.

a. Kind of current to be supplied.

The voltage, phase, form (alternating-current or direct-current), and frequency of the current to be supplied to the purchaser are fundamentally important points to specify, regardless of the business of the recipient. On account of the intricate nature of electrical phenomena and the difficulties of adapting miscellaneous apparatus to specific services, a steady supply of energy must be assured to the recipient of the power delivered, and such a specification in the agree-

ment protects him against injurious or troublesome modifications in the service rendered by the transmission company. Unless the above characteristics of the current are definitely set forth the systematic development of the consumer's business and its economical operation with suitable equipment may be jeopardized by changes in the art of electrical supply. Such changes may in time require modifications of the system of the power company, but special provision for this can be included in the contract elsewhere to advantage, as indicated under "Establishment of Service," clause e. In the central-station field no little difficulty has at times arisen from changes in the voltage and frequency of the current supplied, in order to meet the economic conditions attendant upon progress in electrical design and manufacture. In the large power field such changes are likely to be relatively infrequent, for the cost of making them over an established system of great area is enormous, and the matters of frequency and phase are pretty well settled when once established. The principal change likely is the raising of the transmission voltage as loads increase and insulation design advances. This need not affect the purchaser to any serious degree if proper provision for such a change is included in the contract as above suggested.

b. Points of delivery and recipients.

The places where the service is to be delivered to the purchaser or his authorized recipients should be clearly set forth. There may be but a single spot on earth where the purchaser can utilize the power that he buys, but that spot should be defined in unmistakable terms. Such a course insures delivery at a point convenient to the purchaser regardless of the changes in conditions on the lines of the power company, and it releases the latter, on the other hand, from supplying energy at inconvenient points on its system according to unexpected future demands of the recipient. If conditions require that a certain area should be reserved in which the purchaser may tap the power company's system, such an area should be limited in express words in the agreement. Provision may rightfully be made for the supply of power at points not at present known, on suitable request, but the financial responsibility for such demands should be clearly assigned. Changing conditions may alter the route of a transmission line or require the location of a sub-station at a new site. The power company may meet such a situation as provided for below, but spasmodic changes in the point of supply should not be permitted. Accurate estimates of the cost of supplying service cannot be made unless the

points of delivery are closely limited, and this means that equitable rates demand the complete specification of physical locations where power is to be taken, in the ordinary course of business.

Statement of the authorized recipients of service may appear unnecessary from the practical point of view when dealing with an industrial plant or an electric-railway system, but for the sake of completeness it is desirable to include it. Irresponsible parties have no business with the handling of power of the character in mind here, and tapping of high-potential lines for sub-sales has no place outside a specified agreement to that end. In supplying energy at pressures of from 6,000 to 100,000 volts the responsibilities and regulations need to be defined with absolute clearness, not only to protect the transmission company from illegitimate competition, but to prevent accidents of the most terrible character. The modern transmission line carries literally chained lightning. Where the sales of power for motor or lighting service, or in fact for any other utility, are made to a municipality or central station, it is essential to embody in the contract a designation of authorized recipients in order to protect all parties. The most noteworthy example of this practice that has recently come to hand is that of the entrance of the Connecticut River Transmission Company into the power field of the city of Fitchburg, Massachusetts. The local central station appealed to the Gas and Electric Light Commission for the protection of its small power business, and after a number of public hearings in which the testimony of engineering experts and the arguments of distinguished counsel were threshed over, the Transmission Company was prohibited from supplying energy to consumers of less than 300-horse-power installation capacity and 450,000 horse-power hours consumption per year. The power agreement in this case between the two companies was therefore based upon a decision sharply defining the authorized recipients of service, and the result is a solution of sound benefit to the community, with little chance for future dispute between the parties as to their proper market.

c. Times of delivery.

If non-continuous service is desired the fact must be stated, in the interests of harmonious relations and economy in investment on the part of the power company. Economy of operation depends not a little upon the hours during which service must be supplied. With certain kinds of customers the time requirements will vary considerably, and provision for flexible supply on receipt of due notice may well be in-

cluded in a broad contract. If at certain periods of the year or at certain times of the day the service can be regularly supplemented by other agencies than commonly apply, the approximate limitations in time should be given for the benefit of the power company, which may thereby store water or run its boilers banked, and of the purchaser, who may know definitely when to anticipate approaching demands upon his supplementary equipment.

d. Amount of service to be rendered.

The importance of stating the power demand to be supplied need not be enlarged upon. In some cases it may be expedient to state the maximum, minimum, and average capacity in kilowatts which the power company is to be prepared to supply, but in general, the maximum demand probable for any considerable time is the point of chief importance to ascertain. Local conditions and especially the relative capacity of the power-transmission system and the purchaser's installation will determine the load limitations desirable to express in the contract.

The purchaser in each case should be able to count upon a certain maximum supply and the power company upon a certain minimum demand, unless the rates provide for a minimum charge which offsets long periods of light load. Even in cases where the power is sold at a fixed yearly price and on a 24-hour per-day basis, it may be desirable to state the limits above which the transmission system may not be expected to supply energy unless specially notified. No fixed rules can be laid down here, but in general, the closer the idea that the transmission company obtains of the load curves (probable and actual) of its large consumers, the more economically can the system be operated, and the more reliable will be the service. Where demand meters are installed and the capacity of the power system is many times greater than the maximum possible demand of the consumer, the contract may rightly set no limit upon the supply other than the capacity of the receiving apparatus, but since the investment depends to no small degree upon the maximum demand upon the transmission and generating system as a whole, the total capacity of the consumer must either find an expression in the methods of charging or in the stated volume of service which is required of the power company. In a recent electric-railway power contract the maximum supply which the power company is bound to deliver is limited to the safe carrying capacity of the apparatus in the sub-stations at the time of execution, with a special provision that nothing in the agreement is

to be understood as requiring the power company to install additional equipment in the sub-stations.

e. Expansion and contraction of service rendered.

Changes in the volume of service rendered are frequently incidental to large power sales. Improvements in equipment may lower the energy demand for a given service, as in the substitution of tungsten lamps for certain street or commercial lighting. Changes in the methods of manufacturing in an industry formerly using large amounts of power may diminish or increase the load upon the transmission system, or business expansion may surpass all previous estimates of the power requirements. A flexible agreement will therefore provide for the increase or diminution of service upon a suitable notice, and if necessary limits will be set above and below which the power company will not supply or the consumer demand. This practice of allowing for future development makes the contract much more comprehensive, enables the transmission company to anticipate additional demands to advantage in the market for machinery and with economy of time in designing extensions, if necessary, and in general fits the agreement to meet unforeseen conditions to just the extent to which it is made all-inclusive.

f. Quality of service to be supplied.

Under this heading may be inserted provisions in regard to the range of voltage and frequency fluctuations permissible without deductions by the purchaser on the ground of inferior supply, with definition of what shall constitute an interruption, and possibly a limitation of the power factor to a certain minimum at the receiving point with a specified load. It is obvious that high-class service must be characterized by first-quality regulation on the transmission system as the load rises and falls, and equally clear that unless the energy supply attains certain limits of steadiness, it will be ineffective and perhaps actually injurious to the purchaser's equipment. The range of fluctuations permissible cannot be set down here for specific cases, for expert treatment of each installation alone can determine what the safe and economical limits may be. In one recent high-voltage power contract an interruption is defined as a cessation of the supply of energy for more than 15 consecutive minutes as shown on the meter charts, for any cause for which the consumer is not responsible. Any interruption longer than 15 minutes and less than one hour is figured as an interruption of one hour in making settlements.

In other cases, of course, this definition would be entirely unsatisfactory, and the exact number of minutes of interruption would be penalized at a fixed rate per minute.

g. Utilization of service by recipients.

This point in a well-drawn contract properly sets forth the character of service to be operated from the energy supplied. Here again local conditions intervene to render any general specification useless. The service may have an unlimited range, or it may be strictly confined to one use. Sub-sales may be allowed or prohibited, according to circumstances, and to customers specified as under "Definition of Service and Recipients, b." In many cases the transmission company guards as well as it can against competition by prohibiting resales or sub-sales in the local field that it supplies. An exception might be made here if the customer of the power company were a central station, which could properly be allowed to sell hydro-electric energy to local consumers of small capacity at a profit that represented a reasonable return on the cost of handling the energy and performing the clerical work and usual local duties in regard to the local customers. Large power companies tend toward wholesale business and frequently desire not to be burdened with small transactions.

h. Preferred customers.

In some cases the purchaser may represent himself to be of such public consequence that in case of a partial failure of the power company's generating capacity, his service should take precedence over that of others. Such a case might be afforded by a large city dependent upon the power company for its entire supply of electricity, or by a great railway system dependent upon a large power organization for the movement of its traffic over an extensive area. In such an instance the power contract might provide for a preference in case of a shortage, leaving the power company to make financial restitution to the smaller and less important customers on its lines in case it is able to operate at only a part of its normal capacity. The greatest good of the greatest number is clearly the issue here.

2.—PAYMENT FOR SERVICE.

a. Prices for service to be rendered, including extra demands.

A full statement of the rates and methods of charging for the service to be rendered is of primary importance. Examples of rate applications may properly be included in unusually complex situations.

The prices to be paid for extra demands above certain established maxima should also be included, if such exist. These rates should all be stated in terms so clear as to be unmistakable. Upon them hinge the profits of the contract. Space cannot be taken here to review the importance of the most exhaustive studies of the commercial situation before committing rates to paper in contract form. Whatever the system of charging, it should be consistent throughout the area served. In some cases a progressive reduction in rates may apply as the years pass; in others it may be necessary to provide for a review of the rates at some distant date, on appeal by one party or the other to an established authority acceptable to both the company and the purchaser. Too much care cannot be taken to see that the rate policy is one which will reasonably withstand the wear and tear of time, with changes in the art and possible adverse action by State tribunals on appeal of local consumers.

b. Measurements of the service.

If the energy sold is metered, the contract should state the points at which the instruments are to be located, who shall install and maintain the meters, and how frequently the meter shall be read. The volage of the circuits from which measurements are to be taken should also be given, with specific statement of the electrical location of the apparatus. When this is done, the chances for dispute are greatly reduced. Presumably the power company will read the measuring equipment, but the responsibility for this work should be incorporated in the agreement.

An interesting example of determining the maximum load as a basis for monthly charging is afforded by a recent power agreement between a city in Canada and an electric power company of large facilities. The bills are made out with a partial reference to the maximum load for 20 minutes on all the meters, which are of the curve-drawing type. The maximum readings of all the meters are not added together to determine the 20-minute maximum, however, unless they happen to come at the same time. Thus, if the maximum readings of four meters are 500, 100, 200 and 300 kilowatts, the sum for which the payments are made is not 1,100 kilowatts, but the sum obtained by adding together the readings of all the meters at the hour when the greatest demand for a continuous 20-minute interval is being made upon the system by all the sub-stations of the purchaser.

To facilitate this the scales of the different meters are made as nearly as possible alike, so that in each month a curve may be plotted

showing the combined readings of all the meters, and from this curve the bills are written unless the minimum power contracted for (Definition of Service, d) exceeds the curve values.

c. Tests of measuring equipment.

Where meters are in use the contract should contain a provision for the testing of any instrument at the request of either party, and in accordance with a defined standard or in a stated laboratory. The cost of such tests may properly be borne by the party whose judgment is at fault in regard to the accuracy of the meter. Certain reasonable limits of accuracy may fairly be applied in the contract, and either party should have access to all meter readings and the privilege of installing check instruments if desired. In the contract recently executed between the Canadian parties indicated any two meters in the same sub-station which differ more than 5 per cent may be tested and recalibrated upon the request of either party. Any percentage of error found applies as a correcting factor up to that date in the month in which the meter is cut out of service for calibration, but preceding months are not affected. This plan of leaving out any back rebates is a good one, as it stimulates interest in the accuracy of the meters month by month.

d. Billing and collections.

A proper statement in the execution of a large power contract is the date each month at which bills shall be rendered, the date at which any discounts shall expire if the charges are unpaid, and a designation of the parties authorized to make collections and to render bills in cases where more than one organization is concerned with the sale of energy in a given district. Where large consumers are supplied by the power company in the same community with a co-operating central station, it may sometimes be expedient to state in the agreement between the companies that the power company shall make its own prices and deal with its own customers independently as regards meter readings, billing and collections.

e. Penalties for non-payment for service.

A carefully prepared contract should include provision for the course to be followed, if desired by the power company, in case the customer fails to pay for his service within a specified time after due notice has been given him. A reasonable time should be allowed, and it should not be permissible for the power company to cut off current

until that time has elapsed. Appropriate reference should also be made to the payment of accrued liabilities before the resumption of service. The details of arrangements of the above kind may well be left to local executives.

f. Rebates for service impaired or not rendered.

A clear statement of the amount of rebates and the method of notification in case of service defects or interruption is essential where penalties of this kind are agreed upon. The cause of the impairment of service, if known, should be assigned in complaints, and in general such matters should be dealt with in writing, and preferably within a few days after the service failure, at the latest. In the Canadian case above mentioned if an interruption of 15 minutes or more occurs, the city becomes entitled to a pro-rata deduction from the service charge during the period of power cessation upon giving written notice to the company within seven days. The deduction is then figured with reference to the power taken in the preceding calendar month at the substations where the interruption occurs, and the calculation is based upon the 20-minute maximum of the then preceding calendar month. Local conditions, of course, determine the wisdom of including or omitting regulations of this character in a power contract of broad scope.

End of Part I.

THE PLANNING AND BUILDING OF INDUSTRIAL PLANTS.

By Charles Day.

Mr. Day's first two articles in this series, published in September and October, were based upon a lecture delivered May 5, 1909, before the Graduate School of Business Administration, Harvard University. The mode of attacking, analyzing, and solving the problems of factory construction is so original, so thorough, and so valuable for general use, that the series has been completed, at the invitation of THE ENGINEERING MAGAZINE, for wider presentation. As here presented, the original matter was revised and adapted, and these later installments have been specially prepared to cover the phases of construction and occupancy. The part now presented concludes the discussion.—THE EDITORS.

THE preceding paper concluded the discussion regarding the preparation of the detail plans and specifications required for the building of industrial plants, and it only remains to take up the question of compensation for this work before considering the problems presented during the period of construction.

The practice of making the charge for the preparation of detail plans and specifications a percentage of the cost of the operation has long been established, and in so far as building work is concerned, this method is practically universal. The rulings established some years ago by the American Institute of Architects have been adhered to generally by competent architects and engineers who prepare such plans and specifications, and until very recently this schedule of charges was briefly as follows: For entirely new work a minimum commission of 5 per cent of the final cost of the operation, plus the wages and expenses of one or more superintendents of construction located permanently on the work and also traveling expenses. This fee provided for the making of preliminary sketches, preparing detail plans and specifications, securing bids, letting contracts, and superintending construction. Three-fifths of the total fee, (amounting, in the case of the minimum, to 3 per cent) is for the completion of the work up to the letting of contracts, and the remaining 2 per cent is for the latter service and supervision. As the schedule was drawn specifically as a basis for architect's fees, special rulings were included providing that the owner should reimburse the architect for any expenses legitimately incurred through engaging specialists in connection with equipment details such as heating, ventilating and mechanical, electrical,

and sanitary problems. Unfortunately, the intent of those who prepare this schedule has been widely departed from through the minimum fee being applied to many cases in connection with which special arrangements should be made.

The strictly architectural work incident to the building of industrial plants is usually subordinate to the engineering service, and as engineers have never formulated a standard schedule of charges for their work, but have been guided largely by the rulings of the American Institute of Architects, the matter of their compensation has never been authoritatively established, and is at present in a very unsatisfactory state.

I feel that my papers regarding the planning and building of industrial plants would not be complete unless I take up in some detail the conditions which on the one hand have resulted very recently in the establishment, by the American Institute of Architects, of a minimum fee of 6 per cent, and which are, further, likely before long to bring about the formulation by engineers of a definite basis of charge for the preparation of plans and specifications covering engineering features.

While the percentage plan has certain advantages through its simplicity, and the fact that in general it provides for a sliding scale whereby the compensation increases with the magnitude of the operation, yet as previously mentioned, through the too general acceptance of the minimum fee as a basis of compensation for work of widely different character, its application has proved to be very crude and inadequate as a proper measure of the actual expense incurred.

The inconsistency of a charge based upon a fixed percentage, irrespective of the character of the operation (which was never intended) can be made more clear by citing a few typical illustrations. The plans and specifications needed when building plants for industries which have been largely standardized and require very simple structures, can be readily and economically prepared by those specializing on such operations; whereas many less specialized industries impose unusual conditions that prevent strict adherence to any established precedent. The engineering organization which devotes particular attention to the building of cement plants or cotton mills arrives at certain clearly defined views as to layout and design, and in many instances the only conditions presented by a new commission requiring special study are those relating to output, probable growth, and the specific property. As a rule it is the number of building units and amount of equipment that are chiefly affected by these matters, so that construction details which have become a matter of record

can be directly adopted, and in many cases the desired result is promptly and efficiently obtained through the modification of existing drawings and specifications.

In comparison with this illustration let us consider the work that must be performed by the engineering organization engaged to prepare plans and specifications required in connection with buildings and equipment suitable for the manufacture of storage batteries. At the present time there are not more than four or five concerns manufacturing storage batteries upon a large scale, and it is only at wide intervals that the need of building a new plant or large extension for the accommodation of this work arises. Therefore, the amount of business in this particular field available to the architect or engineer is not sufficient to permit of specialization; and even if an organization engaged for the purpose of designing such a plant had formerly been employed by another client in the same line of business, a knowledge of the designs made in the former case would probably be of little avail. Radically different views exist as to many of the primary features involved, partly because different processes are used by the various concerns in this business, and partly because the number of plants that have been built is too small to emphasize the marked advantage of any one type of structure. Of course, many of the special features involved in such a plant are thoroughly considered during the course of the preliminary work, which service, for our present purpose, must be considered as quite distinct from that of preparing the detail plans and specifications. However, this industry presents numerous problems (one of which is that of providing against the destructive action of the sulphuric-acid fumes) which must be kept in mind when working up the details. When these matters have not been previously investigated, a large amount of research may be necessary, the results of which may have a very important bearing upon matters of design and construction. Then again, frequently many of the smaller industries can be most advantageously housed by accommodating different departments in distinct structures, each comparatively small in extent, and either independently located or merged together, but in any case necessitating an amount of engineering consideration greatly in excess of that required to design a standard building composed of uniform bays, but requiring the same outlay.

The inequality of conditions presented by the two broad classes to which I have called attention, is, however, wider than would appear from the above, for it is customary, and often necessary, to invest in cement plants and cotton mills much more money for buildings and

equipment than is provided for many of the more miscellaneous industries. Therefore, there are plants that to a certain extent at least have been standardized in layout and building and equipment details, and at the same time trade conditions are such that the provision of the required facilities necessitates large expenditures. A fee that would yield a proper profit for the preparation of the plans and specifications under such conditions would represent a percentage of the total cost that certainly would not be an equitable basis for the performance of a similar kind of work in connection with the provision of buildings for the majority of industries, in which the outlay necessary to provide for customary output is much less, but the actual expense of making detail plans and specifications considerably more.

While for my present purpose it may not be necessary to analyze the situation further, yet I wish to point out that even for a given industry the expense involved in connection with the preparation of plans and specifications for new buildings and equipment does not increase directly with the size of the operation—that is, its total cost—but at a somewhat lower rate. Designing a cement plant for 5,000 barrels per day does not necessitate a great deal more study and drafting work than designing a plant for 2,000 barrels per day, nor does a storage battery plant for an output of 200 cells per day require a great deal more designing work than one for 25 cells.

I have not differentiated between the preparation of plans and specifications for buildings proper as distinguished from those needed in connection with the manufacture and installation of equipment, for in general the same line of reasoning applies in both cases. I have previously pointed out that a considerable part of the equipment used in industrial plants is built upon a manufacturing basis, and the engineer's function is merely that of selecting the type and make that best suits the requirements. On the other hand, there are cases where special processes necessitate the use of apparatus which is not available and therefore must be designed and built for the purpose. And then, again, there are requirements which can be satisfied in part through the use of standard apparatus, but need also certain special auxiliary appliances to make the equipment complete. Consequently, the actual engineering expense varies greatly when providing equipment which necessitates the preparation of specifications and suitable information to accompany them, together with a proper consideration of the data received with the bids. The records of an engineering organization handling a wide range of work show that while this expense may not exceed 3 per cent when purchasing standard industrial apparatus and power-plant equipment, it frequently runs up to

15 or 20 per cent, and occasionally much higher, when detail designs must be made for apparatus that is wholly or in part original in its conception.

A proper recognition of the conditions to which I have endeavored to direct attention must convince the owner, architect, and engineer that a given percentage, irrespective of its amount, cannot be expected to provide equitable compensation for all classes of work. The majority of owners, of course, are quite unfamiliar with the character of work required on the part of the architect or engineer in order to render efficient service, and they have even less knowledge of the cost incurred through its performance, nor can it be expected that conditions should be otherwise. They should realize, however, that the very nature of the service is such that any conditions that tend to establish an incentive for superficial work may prove most damaging in the ultimate result.

Competitive conditions among architects and engineers, together with this lack of knowledge upon the part of owners, have resulted in the establishment of a fixed percentage fee, which, in the majority of cases, will assure a profit only when expenses are minimized through the adoption of a procedure that is detrimental to the owner's best interest. Evidences of this are numerous, the most prominent illustrations being the transfer of the preparation of plans and specifications from the office of the architect or engineer to the office of the contractor or manufacturer. The contractor, of course, urges the adoption of this method as it places him in a somewhat more advantageous position when bids are solicited, and in some cases by this means he is able to eliminate competition entirely. I refer, of course, to such features of the work as should be cared for, without doubt, in the office of the architect or engineer. The primary object in preparing detail plans and specifications, in the manner outlined in my previous paper, is to define clearly the character of the structure or apparatus desired, and to establish an impartial basis for competition. When the contractors or bidders make their own plans and specifications for such matters as structural steel work, piping systems, etc., comparison of performance, and therefore of prices, is frequently very difficult. Further, the contractor includes in his bid an amount for the preparation of such plans and specifications so that ostensibly the owner is paying for the work twice. On the other hand, architects and engineers as a class have been forced into this position through their lack of aggressive and united action. Analysis of the records of such firms as have been able to create profitable businesses without sacrificing thoroughness invariably shows that, upon a 5 per

cent basis, the costs of much of their work amounts to, or even exceeds, the figure that this commission will realize. It is only the large and comparatively simple operations that can be made to yield a profit on a 5 per cent basis.

Fortunately this condition has been partially corrected through the action of the American Institute of Architects establishing a minimum fee of 6 per cent above referred to; but a relationship between owner and architect or engineer tending to promote efficient service will not be attained until the conditions that I have outlined are properly appreciated, and until owners recognize that when arranging for such service as we have had under consideration, their interest will be best served through carefully considering all reasons that may be advanced in justification of a given commission. This is especially true if the amount of the commission happens to be in excess of the minimum, owing to the belief on the part of the architect or engineer that the conditions are such as to necessitate a special charge.

C—Construction Work and Installation Equipment.

During the period when the detail plans and specifications are in course of preparation, a clear understanding should be reached between the owner and the engineering organization as to the procedure that will be followed in connection with the actual construction of the buildings and installation of equipment.

The customary method is to submit the plans and specifications for bids to responsible concerns who are in a position to handle the various classes of work, and when this plan is to be followed it is only necessary to determine what policy shall be adopted in regard to the letting of the work in either large or small units. Certain engineering companies organized to handle the preliminary and detail engineering work that have been described, have construction departments perfected with a view to taking direct charge of the erection of buildings and installation of equipment. When such a company is employed its construction organization offers a second method for the handling of this part of the work. Occasionally an owner decides to carry out through his own force the work illustrated and described by the engineer's plans and specifications, this being the third plan that is possible.

Owing to the widely diversified conditions incident to different industrial organizations and properties, each of the methods referred to can be advantageously adopted under different circumstances. There is no doubt, however, that the third plan, viz., the direct as-

sumption by the owner of entire responsibility for the construction of the work, is becoming less frequent and is desirable only where the nature of the industry to be housed is such as to necessitate the maintenance of a construction force organized to handle work along essentially the same lines as that presented when building a new plant. The amount of work that has as yet been handled in accordance with the second method is comparatively small, although probably now amounting to several million dollars annually, as there are only a few organizations that are prepared to render jointly thorough engineering and construction service. There are many reasons, however, several of which will be pointed out later, that make it very desirable at times to place entire responsibility for the planning and building of industrial plants in a single company, so that there is no doubt that an increasing number of the competent engineering organizations will create construction departments, and ultimately it is not unlikely that industrial work through the building period will be divided about equally between operations that are let by contract and supervised by the engineers, and those that are handled in their entirety by engineering organizations.

In order that the procedure in each case may be generally understood we will consider the subject under the six sub-divisions contained in the classification appearing in my first article. I will first deal with the method of letting the work by contract, the supervision being exercised by the engineering organization which prepared the plans and specifications.

C-a. Select responsible concerns to bid upon plans and specifications and secure bids from such parties.

In the majority of cases, when new industrial plants or large extensions to existing properties are built, it is advisable to secure bids upon the complete building or buildings rather than separate bids on the various features of the structures such as the concrete work, steel work, brick work, and mill work. The reason for this is that the architect or engineer whose organization does not include a construction department, cannot be expected to be conversant with the problems that confront the general contractor, nor be responsible for matters the proper attention to which demands a totally different character of organization. It is, however, imperative, if an expeditious and economical result is to be secured, that responsibility for the building work as a whole should be centered in a single company.

One of the important functions performed by a competent engineering organization is the selection of responsible bidders for the

buildings and other features of the plant, and while the owner's desire in this regard should be sought and carefully weighed, the owner should be careful not to influence his engineers to too great an extent unless quite certain of his ground. Repeated experience with many contracting firms of varied financial responsibilities, located possibly in widely different sections of the country, trains the engineer rapidly in the problem of making wise selections, and his grounds are often of so subtle a nature that it is difficult to satisfy his principals thoroughly as to the correctness of his judgment. This matter is one of the utmost importance, and the policy and procedure followed in regard to it by a given organization is a direct measure of their business ability and impartiality. It is not only eminently unfair to ask contractors or manufacturers to figure upon work when it is practically a foregone conclusion that it will not be awarded to them, but such methods (even if unconsciously sanctioned) soon result in a knowledge by those who bid that a strictly square deal is not always forthcoming, so they not only take little pains to figure closely, but sometimes intentionally submit high figures. Therefore, this must be taken into careful account by the owner when selecting his engineers. The engineering organization, on the other hand, should be equally firm, during their relations with their respective clients, and stand absolutely for a clean-cut policy that is as fair to those who bid upon the work as to the owner.

Occasionally it may be desirable to include, in the general contract, the service equipment; that is, the equipment required for lighting, heating, sanitation, water supply, fire protection, elevators, and any other apparatus required to make the building itself complete in all respects, irrespective of the special manufacturing apparatus. Usually, however, these features can be let more advantageously as separate units, for each of them is sufficiently definite to obviate the likelihood of either overlapping of work or failure to contract for all essential details. All that I previously said in regard to the selection of bidders is particularly pertinent to the equipment features, although it must be understood that it is necessary in many instances to secure bids on apparatus of different types in order to obtain the manufacturers' guarantees as to performance, which data, along with the actual bids, form the basis for decision as to the particular equipment best suited to the conditions. As an illustration, it is occasionally desirable to secure bids on both reciprocating engines and steam turbines, as rapidly changing conditions may make the use of data and bids previously secured an unsafe basis.

C-b. Tabulate bids, confer with owner, followed by placing of contracts.

When asking for bids on a building or buildings it is almost always desirable to require the bidders to present alternate figures covering certain features in which two or more different methods or types of apparatus should be considered, and also to have included unit prices covering such classes of work as footings, brick work, etc., so that charges or credits can be figured upon an agreed basis in event of modifications in the plans. Owners and engineers as well are prone to underestimate the amount of time that is required to prepare, intelligently and accurately, a bid relating to a considerable piece of work, including possibly a great number of alternate figures and unit prices, so that very frequently an insufficient amount of time is given for this purpose. It is obvious that bidders who are compelled to rush through their estimates will "play safe," and the resulting figures will be unduly high. This should be guarded against, especially in connection with all the more important negotiations.

It is equally important that time should be allowed for a careful tabulation of bids before any conclusions are drawn, for first impressions are almost always based on the main lump-sum figures, whereas very often a study of the tabulated data (including, in addition to the figures already referred to, time for completion, and, if the bids relate to equipment, efficiencies of operation and detail descriptions of construction features) prompts an entire rearrangement of the bidders in so far as the desirability of their proposals is concerned.

After the tabulated bids have been subjected to the proper study, the engineers not infrequently find it necessary to confer with the concerns that have submitted them, and the question of price should be carefully gone over, each bidder being given an equal opportunity to better his quotation, either in accordance with the original or modified specifications, as the case may be. The engineer then draws his own conclusions and confers with the owner, securing finally the authorization required to close up the transaction.

So much for the various contracts considered individually. Considered jointly, however, it is evident that they bear an inter-relation to each other in so far as construction and installation of equipment are concerned, that must be taken into careful account in order that the work may go forward uninterruptedly and without one contractor interfering with the work of another, or doing work which must at a later date be undone. In order to accomplish this end a schedule

must be prepared in advance, showing the order in which the contracts are to be let, unless the operation and incidental conditions are such that the soliciting of bids can be postponed until plans, specifications, and contracts are completed and can go out simultaneously.

C-c. Superintend building construction and yard work.

There is no period in connection with the building of industrial plants when strict attention to details and at the same time a broad grasp of the work as a whole is more imperative than when the field work is going forward. Much depends upon the foresight that is shown by the engineer in his selection of a superintendent of construction, although in the final analysis the policy must be dictated from the home office, where control must be centered. This is usually a particularly trying time for all concerned; for if it is a new industrial plant, or more especially an extension to an existing property, the owner is not only eager to have the work completed so that operations can be commenced, but only too often cannot resist the temptation to take a hand in the construction work. He cannot have a sufficiently comprehensive grasp of the problem to realize that in order to promote the work as a whole expeditiously, many minor conditions are bound to develop which, considered individually, may appear to have been unnecessary and wasteful. However, the very nature of construction work is such that the most the engineer can hope to do is to minimize minor troubles, and the owner must measure the success of the work by the final result. The locomotive engineer does not stop his train if his gauge glass is broken, but gets along with the gauge cocks on the water column until a suitable time to make repairs. The owner who endeavors to dictate during the construction period without having a proper grasp of the problem as a whole may readily delay the entire work, much as would the inexperienced locomotive engineer who brings his train to a standstill in order to take care of a minor matter, attention to which should not interfere with the accomplishment of the principal object in view.

In the past the tendency among architects and engineers (and owners as well) has been too often to look upon contractors collectively and individually as parties whose interests are so diametrically opposed to those of the owner as to warrant an attitude of perpetual suspicion toward them, which the same architect or engineer would not countenance for a moment toward manufacturers of apparatus and materials. There are, of course, unscrupulous contractors, just as there are unscrupulous engineers and architects, and the contractor

has conditions to contend with, owing to his financial requirements, that unfortunately have frequently prompted methods which should not be permitted. All these matters should be taken into account by the engineer prior to selecting his list of bidders, and thereafter in his business dealings he should recognize in the contractor to whom the buildings have been awarded a man confronted with problems, if not as technical as those with which he himself deals, yet much more subtle and requiring for their proper accomplishment forceful methods which would not be appropriate in the drawing room or the shops of an organized industry.

C-d. Superintend installation of "service equipment" and all standard and special machinery or appliances needed for industrial purposes.

Usually, if the plant is a large one, a superintendent of construction especially experienced in mechanical and electrical matters should be employed during the installation of the power-plant equipment and special machinery. Very frequently the engineer's recommendations in regard to equipment are accepted by the owner wholly upon the statements that have been made to him, and the best interests of all concerned can be assured only through the engineer taking the initiative in the starting up of such equipment, having demonstrators on hand if their presence is desirable and making such tests as are required in order to substantiate his original statements. The owner who contends that one superintendent of construction, with assistants of comparatively limited experience, can properly look after the buildings of a large industrial plant, argues directly against his own best interests.

C-e. Check work as to quality and amount and approve invoices.

The checking of work as to quality and amount commences almost simultaneously with the field work, and must be provided for through a system of records and definite plans of procedure which experience will have indicated as desirable for the different sections of the operation. The plans and specifications must be in sufficient detail to enable the superintendent of construction to inspect decisively materials as they arrive, except where shop inspections or laboratory tests are required (illustrated by the inspections made at plants where steel is fabricated, or in laboratories where samples from each shipment of cement are forwarded for testing purposes). In such cases provision must, of course, be made for immediately notifying the superintendent of construction, through the home office, of the results that have been obtained.

Following the inspection of materials comes the inspection of work, and finally the inspection of performance where operating mechanisms are erected. The system at the home office must be such that all reports as they are received are properly filed with the contract or order to which they apply.

C-f. Certify as to completion of contracts.

The engineer in charge of the work (who should preferably be the man in whose hands the chief engineer has placed the preparation of the plans and specifications) must co-operate with the superintendent of construction in the preparation of estimates as to the work completed in accordance with the terms of the various contracts and orders and, of course, all the records regarding receipt of materials, inspection, tests, etc., must be taken into account when certifying as to the payments that are due.

The foregoing covers the principal points upon which the success of a construction operation depends when the various features of the work are awarded to contractors and the field work in all of its phases is directed by the engineer who prepared the plans and specifications. It will not be necessary to take up in the same detail the procedure that is desirable when the construction work is handled by the engineering organization that prepared the detail plans and specifications, as this would in part result in a repetition of what has already been said. It will be necessary, however, to compare the methods of compensation that are usual and desirable in the respective cases, and to define approximately the conditions under which the contract method or the handling of the work directly by the engineering organization works out most advantageously. After all, these are the two points in which the owner is most interested; and if those who are prepared to render both the engineering and construction service strictly limit themselves to one or both branches of the work, according as conditions may indicate to be best, the advantages that the assumption of the entire responsibilities offer will be emphasized and much more work will be done on this basis than at present.

In the first place it must be taken for granted that only such engineering organizations as have proved themselves competent to handle construction work will be considered, and, as a matter of fact, the issue is definitely presented only when the firm which has prepared the detail plans and specifications happens to have had this requisite experience.

The procedure in this case differs from that followed when the work is let by contract, in that the engineering organization, instead of sending the plans and specifications to construction companies, will have prepared in its own office accurate bills of material and secure first-hand competitive prices, many of which it is usually necessary to obtain in the market adjacent to the locality of the new plant. Schedules of all the bids are prepared, and on each important purchase the owner's approval should be secured before a contract or order is finally awarded. The question of order of work is of even more importance than when the engineer merely superintends the construction, for the manner in which every part of the work progresses depends in the final analysis upon the foresight displayed in anticipating requirements.

The man to whom the field work is delegated is responsible for the employment, through his foreman, of all common and skilled labor, and the superintendence of the work becomes the function of a member of the engineering organization, preferably of the engineer who was in direct charge of the preparation of plans and specifications. This man will have taken an active part in the purchase of the principal materials and equipment entering into the operation, and consequently has an intimacy with the entire project that proves of the utmost value during his later service as superintendent. The engineering organization is, of course, responsible for providing the necessary construction equipment, and, in fact, assumes charge of the entire operation in its every aspect, for it is the advantage this condition offers that usually makes such an arrangement so desirable.

The only feasible basis upon which to remunerate an engineering organization for such service is a fixed fee or percentage of the actual cost, for the economies effected through the competitive purchase of all materials just at the time they are needed, directly from those who can quote the lowest prices, should accrue to the owner. As a matter of fact, the owner is, to all intents and purposes, handling his own construction work, having engaged for this purpose a corps of specialists much as he would engage experts in connection with the conduct of his own industrial work. The services rendered by the engineering organization should be considered in no wise less professional than the work previously performed by them, resulting in the plans and specifications.

The materials would be purchased, under such an arrangement, at quite as favorable terms as could be secured by a contractor, and an equally satisfactory basis arrived at concerning the employment of skilled and common labor, and at the same time the actual assembling

of these materials into the final structures and the installation of the equipment would be under the direct control of those who know the exact reason for the provision of every single feature; and their knowledge of future operating conditions enables them to exercise an intelligent discretion that should result in a more harmonious whole than could result solely through a literal adherence to the most elaborate specifications.

A great deal has been said in defense of both the "lump-sum" and "percentage" methods of handling construction work, and I do not propose to enter into this discussion in these papers. I have assumed, when discussing the plan of building industrial plants by contract, that the engineers would exercise conservative judgment as to the basis of compensating the various contractors. There are certain instances where the percentage or fixed-fee plan is the only one that is at all feasible, viz., where it is quite impossible to foresee with accuracy the conditions that will be encountered, or where speed is a matter of paramount importance. Then again, there are other conditions which as definitely call for the lump-sum basis. The conditions are, however, radically different when the construction work is handled by an engineering organization, for whatever advantages the lump-sum method may offer are outweighed by those resulting from the direct assumption of the owner's interests, secured through the fixed-fee or percentage plan.

When speed is of primary importance the work can often be greatly expedited by following the plan now in question, as certain features of the construction work can be commenced some time before the completion of the final plans and specifications. This method is always preferable where it is imperative that the owner should have direct control of the construction work, as when an extension is being built to an existing plant and the field work must be subordinated to the requirements of manufacture.

Before concluding my remarks regarding this method of procedure, it is necessary to call attention to the necessity that those who undertake this plan of work shall have had thorough experience under just these conditions; for unless this is the case, a situation may easily be brought about that results in losses far exceeding any advantages that may have been obtained. One of the first requisites is a system whereby the entire costs of the work will be properly classified and reported on cost sheets where an immediate comparison can be made with the original estimate that was approved by the owner. Statements should be presented to the owner monthly, showing the exact status of each subdivision of the work, giving the amount of the

original estimate, the money that has been paid or is due for this same subdivision, and the obligation that may have been incurred but is not yet due.

Every change in the plans authorized by the owner, whether of minor or major importance, or whether adding to or deducting from the amount of work covered by the estimate, should be accurately put on record with just as much care as would be displayed by the lump-sum contractor. The original estimate should be modified accordingly and the owner's approval of the change secured, thus obviating any misunderstanding as to the estimated total outlay. Probably lack of attention to this matter has done more to create a prejudice against percentage work than any other factor, for only too often have owners been seriously misled as to the disbursement that will be required, because of failure to place properly on record the cost of changes or additions authorized during the construction period.

Practically all the reasons advanced in favor of the preparation of detail plans and specifications by engineering organizations, rather than by engineers that may be in the employ of an industrial company, apply in the case of the handling of construction work by construction organizations that do nothing else, as opposed to a force of men brought together for this purpose by an industrial company and directed by them. Unless the routine conduct of the industrial company's affairs includes as one of its functions the maintenance of a construction force organized specifically for such work, the only way that they can directly control the operation in a broad manner and at the same time expect an efficient result, is to retain a thoroughly organized force of experts in accordance with the manner that has already been outlined.

M.—Period of Occupation and Commencement of Operation.

It is customary for industrial managers who are confronted with the necessity of providing new quarters for the conduct of their business, to believe that all problems incidental to the period of occupation and commencement of operations should be handled directly by them. This is largely true if the engineering organization has been retained only to superintend the work performed by contractors, but if their service also includes the performance of the construction work, and especially if they have had charge of the operation from its inception and have taken the initiative in all of the preliminary investigations, their co-operation during the period in question may be of the greatest value.

M-a. Move equipment and accessories from old plant into the new, transfer force and start up work.

Each commission presents special conditions which must be taken into account when moving from an old plant into a new one, or when rearranging departments and equipment in existing quarters with a view to occupying extensions that have been built. Usually this work can be done to best advantage in a very gradual manner, and yet it should be pushed forward decisively and in accordance with a carefully predetermined plan.

M-b. Correct minor discrepancies that invariably evidence themselves after the plant as a whole is put into operation.

The engineering organization should in any case be able to render very efficient service during the period of occupation, but the knowledge they possess is of particular value in regard to the correction of minor discrepancies that invariably evidence themselves after a new plant is put into operation. They are usually in themselves small matters which, if it were not for the critical attention of someone to whom the work was specifically delegated, might not be corrected.

M-c. Train the force of administrators and operators along the lines necessary to bring about the most efficient utilization of buildings and other facilities provided.

It is invariably the hope of those who build new industrial plants or large extensions to existing properties, that the work of manufacture will be conducted somewhat more efficiently under the new conditions than was previously possible, and as in some cases this is the principal motive that prompts the building work, it is evident that interest in the proposition as a whole must not be allowed to flag as construction nears completion, but should rather be stimulated as the time approaches when the merits of the layout can be measured. Usually the greater part of this responsibility devolves upon the owner, although the engineering organization should take the initiative in demonstrating results wherever it is possible to do so, and especially in connection with those matters regarding which the owner accepted his recommendations.

As I have proceeded with the preparation of these papers concerning the planning and building of industrial plants, I have been impressed with the magnitude of the subject, and as I conclude the discussion, I realize thoroughly the inadequacy with which I have been compelled to handle many phases of it. If, however, these papers prove of any material assistance to anyone who is confronted with the problems with which I have dealt, whether it be owner or engineer, I shall be satisfied that they have at least been useful.

EDITORIAL COMMENT

The Age of Pillage.

DISCLOSURES of fraud apparently involving high officers of the American Sugar Refining Co. and the United States Customs service, and threatening to develop into one of the most disturbing sensations the United States has known, serve to emphasize again an often-stated proposition—that what the country needs most is not more laws, but more righteousness. The prohibition of the crimes disclosed needs no legislation more subtle or more recent than the eighth commandment; and if the standards of the men who are tolerated in political and industrial high places are not sufficiently moral to yield obedience even to the fundamental precepts, of what avail is it as yet to spend thought and energy in devising nice refinements of economic regulation? Indeed, it is possible that in the multitudinous clamor of many legislatures and legislators for many measures looking to restriction and control of corporations, upon theories based upon economic expediency rather than absolute right and wrong—theories some of them subject to very serious doubt—attention has actually been drawn away from the real dangers of the industrial situation, and sympathies have been divided, not by the line between right and wrong, but by the line between pro-corporation and anti-corporation sentiment. Public opinion is marshaled into camps quarreling over the question whether or not civilization is endangered by the size of the huge industrial units, and in the heat and fury of the conflict it forgets that the crucial test has always been not "big or little?" but "honest or dishonest?"

It seems, indeed, more than ever, that, as we suggestel in these columns just a year ago, "trust building" is only the latest instance of an often-repeated phenomenon—that is, that every epoch of rapid change in the conditions of industrial civilization is seized upon as an opportunity for plunder by men whose greed is not checked by scruple. Two centuries ago, it was State-craft that afforded the opportunity for pillage, and the man who posed as leader of the world was the sovereign or the minister who plundered his weaker neighbors without conscience and without check except that put upon him by a still stronger power. A century ago, the last of the great military conquerors seized upon the armed activity of Europe and recognized neither law nor conscience in enlarging his grasp of power. A half-century ago piracy had taken to the high seas. A third of a century ago the great railroad-wrecking millionaires of the United States were still an active memory, if a waning element in American finance. But the methods of State-craft have been moralized, even if its rapacity has not been curbed. A repetition of the career of Napoleon is a fantastic suggestion, although the military establishments of the world are larger than ever; and it would be a very modest estimate to say that American railroads are administered with seven-fold the honesty of the days of Fisk and his associates, although they have increased seven-fold in mileage anl probably much more than that in wealth since that time.

The great American trusts must and will follow a similar life history, although at present they are too often but fields for plunder, quickly seen and seized upon by the modern counterparts of Napoleon or of Captain Kidd. The company with a capital of $100,000,000 is no more necessarily dishonest than the 3,000-mile railroad or the 800-foot ship, but it is made dishonest by the

plunderers who profit by its novel conditions, as the buccaneers profited by the rapid growth of commerce on the seas.

There are two great correctives which help the process of reform. One is the gradual enlightenment of public opinion. The other is arrest and punishment of the offenders—St. Helena for Napoleon, the gallows for Captain Kidd, and jail for the bank wrecker. Both remedies seem likely to be in active operation in American industrial affairs in the immediate future.

Early British and American Ship-Building.

IN a very interesting memoir on the evolution of screw propulsion in the United States, contributed by Mr. Charles H. Cramp to the November meeting of the Society of Naval Architects and Marine Engineers, a most interesting light is thrown upon the decline of the American merchant marine. Mr. Cramp does not offer merely the ordinary explanation, that the interruption of commerce and shipbuilding caused by the Civil War lost ground which the American shipbuilders were unable to regain. Neither does he suggest the influence of protection and American navigation laws in increasing the cost of building and running vessels under the American flag. The point that is notable in his treatment of the matter is the important influence he attaches to the indifference of American shipbuilders toward the progress of naval architecture and marine engineering abroad.

"The first iron steamers in the United States," he says, "were fearful specimens of naval architecture; the workmen were the boiler makers of the works and the vessels were looked upon by the engine builders as merely exaggerated boilers." The practice existing at that time of making contracts for the engines and hulls with different builders, he believes, was an extremely bad one; "each party blamed the other for whatever went wrong," and the division of responsibility greatly retarded improvements in steamship construction. Finally, "the great commercial city of New York adhered to the course that led to the ultimate elimination of the United States from the world's commerce. New York interests would not consider any other but the paddle wheel with its walking-beam engine, and as they knew nothing of any other type they loudly proclaimed its great superiority over all other types, and carried with them the ship-owners, shipbuilders, shipping men, mariners, and all others in general; the screw propeller was sneered at by them as a low-down Philadelphia idea." The folly of sticking to this obsolete type of steamer reached its climax with the failure of the three great paddle-wheel steamers of the Pacific Mail Co., "notwithstanding that the methods of their hull construction and design were the finest ever put into a wooden ship, and that by the ablest builders on the planet."

Great Britain, on the other hand, "had at an early date begun to develop screw propulsion" and beginning with "the advent of the fine screw ship, the Great Britain, in 1844," she had been "building ships and engines of the best character and introducing them into the merchant marine and navy." The British, also, "soon began to build the entire ship complete by first-class shipbuilders and the finest specimens of warships and merchant ships were turned out by them." In the United States, Mr. Cramp repeats, "iron ships with their engines were built by boiler makers and machinists, with the most indifferent results." It is unusual to hear so frank an admission of commercial and engineering mistakes as a contributory element in the decline of the American merchant marine, and the admission is the more noteworthy because it comes from the foremost American shipbuilder, whose yards now turn out a product that can be compared favorably with anything that is done anywhere in the world.

Can the United States Revive Its Merchant Marine?

ANOTHER very interesting argument upon the possibility of reviving the foreign-trade merchant marine of the United States is advanced in a paper by Mr. G. W. Dickie, of the Union Iron Works, contributed to the same meeting. The only influence recognized or spoken of by Mr. Dickie is that of legislation affecting the over-sea carrying trade, especially acts of Congress establishing discriminating duties or imposing tonnage duties on foreign ships. Mr. Dickie, however, confirms by figures Mr. Cramp's statement that the decline of the American merchant marine had begun before the Civil War. In 1850 the United States carried an average of 72 per cent of its imports and exports in its own ships. In 1860 the proportion had fallen to 66 per cent, and in 1870 to less than 36 per cent. In 1900 but 12 per cent of the imports and 7 per cent of the exports of the country were carried in American bottoms, and since that date the decline has continued. Mr. Dickie dismisses summarily the enthusiasts and over-optimists who talk "nonsense about the great superiority of American skill which will give and maintain American shipbuilders a superiority and protection that leaves nothing to be feared from the fullest competition." He advances the unanswerable proposition that if ships could be built in America more cheaply than abroad, they would be built. As a matter of fact, Mr. Dickie, who certainly speaks with unquestionable authority, says "national conditions, over which our shipbuilders or ship-owners have no control, and which they are powerless to change, make the cost of building vessels in the United States from 30 per cent to 40 per cent greater than in other countries. The cost of manning and victualing these American ships is also much greater, probably not less than 30 per cent more than manning and victualing foreign ships. In addition, there are other expenses in the operation of vessels which are greater in the United States than they are in other countries, such as taxes, repairs, outfit and equipment. Most of these higher costs are the outgrowth of conditions resulting in the policy of high protection to industries."

Mr. Dickie's remedy is a provision of mail subventions in the amounts necessary to establish thirteen lines of steamships, requiring about 300,000 tons register, and running upon the most important traffic routes of the North and South Atlantic, the Gulf and the Pacific. He proposes the letting out of the subsidies to the lowest bidder, and this policy he believes would secure the required service at the lowest feasible figure and would be fair to all concerned. It is difficult to see how this policy could result in the construction or operation of more than forty or fifty ships under the American flag—fairly adequate as a naval reserve, but not a very substantial command of the seas in a commercial sense. It would seem to merit consideration as a matter of military policy only. Mr. Dickie does not believe that protection measures in the form of tonnage duties, or preferential treatment by a policy of discriminating duties on entering cargoes, could be effectively applied. In this his position would appear to be perfectly sound. Some advocates, earnestly anxious to see the American flag restored to the seas, are pinning their faith to the policy of a preferential tariff on dutiable imports if they are carried in vessels of American registry. As this could be earned only upon cargoes of a certain character brought into the United States, and would be of no assistance to an American ship bringing in non-dutiable cargo, or on her outward voyage, or on a voyage between foreign ports, it would hardly seem to afford sufficient support for any considerable tonnage of American shipping.

The policy of protection naturally leads to reliance on Government assistance for projects of every sort. If the country can enrich its manufacturers by artificial aid, why can it not similarly establish in prosperity any and every class of its citizens? Why shall it not make agriculture wealthy by sugar bounties, or by spending thousands of millions for water supply? Why shall it not confer untold and almost unimaginable benefits upon the whole interior by more thousands of millions for a colossal scheme of deep waterways? If the argument is pushed to its limit, its fallacy becomes evident. We doubt whether even the single undertaking to subsidize shipping sufficiently to restore the American flag to its place on the seas, against the competition of the world, could be achieved except at a cost greater than the revenues of the country could stand. American shipping, as Mr. Dickie says, has been made a sacrifice to "the policy of high protection to industries," and we fear the sacrifice is complete and irremediable.

Industrial Engineering.

NINE years ago, in the conclusion of an article written by Mr. J. N. Gunn for this Magazine, there appeared the first declaration (so far as we know) that the conditions of the times were creating a new department of engineering occupation, differing in its boundaries and its duties from the long recognized provinces of civil, mechanical, mining and electrical work. To this new and at that date scarcely recognized branch of engineering, there was first given also at that time the designation "industrial engineering." From time to time we have noted substantial gains in its advance to more general acknowledgment, until today it may be said that its recognition is general, its literature is considerable and distinctly segregated from other specialized bodies of engineering literature, and its practice has enlisted an important and indeed a distinguished body of specialists. The separation and specialization of this particular form of technical work is the direct result of the rise and growth of manufacturing as a distinctive field of occupation—a field demanding the services of engineers in managing positions. The immediate accompaniment has been a scientific study of the elements of costs in the execution of work such as formerly had never been attempted nor even conceived of. The study was necessitated by the essentially competitive nature of manufacturing—the intimate comparison between the product and prices of rival makers that became possible and inevitable when similar wares were offered in the same market.

The work to which the attention of industrial engineers was first directed was largely analytical. It was concerned with the systematic, scientific resolution of a manufacturing proposition into its elemental units and the determination of their size and influence. Later came the function of directing the remedies for defects and disproportions discovered by this analysis; and from this has grown what is perhaps the largest and most important function of the industrial engineer today—creative work in the introduction and application of systems by which new conditions are created, new possibilities are opened, and new and enlarged efficiencies are secured from the organization, the equipment and the personnel. It involves direction of the influences of conservation in definite directions, and it demands, for its successful practice, the understanding of the factors and forces of production. It requires working familiarity with policies, systems, and institutions by which wastes are detected and remedied and the highest practical economy is secured in the three great divisions of the manufacturers' problem—labor, materials, and expense. To this training the technical schools must give increasing attention.

REVIEW OF THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

PROGRESS ON THE PANAMA CANAL.

A REVIEW OF PROGRESS IN EXCAVATION AND CONSTRUCTION WORK DURING THE YEAR ENDED JUNE 30, 1909.

Annual Report of the Isthmian Canal Commission.

A NUMBER of photographs illustrating certain features of the Panama Canal work are reproduced on pages 391 *et seq.* of this number of THE ENGINEERING MAGAZINE. Below are given in abstract the parts of the Annual Report of the Isthmian Canal Commission, just issued, dealing with the progress in excavation and construction during the fiscal year ended June 30, 1909.

During the year the designs for the upper locks at Gatun and the locks at Pedro Miguel were finished. The locks in pairs, separated by a wall 60 feet thick, are 110 feet in width, with 1,000 feet usable lengths. Longitudinal culverts in the side walls, operated by Stoney valves, connecting by laterals under the lock floors with several openings into the lock chambers, have been adopted for filling and emptying the locks. Other longitudinal culverts in the centre walls, operated by cylindrical balanced valves, and similarly connected with the lock chamber, permit the passage of water from one lock to the other of any pair. The gates are to be of the double-leaf, double-sheathed, straight, mitering type. A fundamental feature of the design of all the locks is that at each flight there must always be two barriers separating the high level from the level next below. The suitability of the horizontal rolling gate to the purposes of this second barrier were carefully studied, but it has been abandoned in favor of another set of mitering gates with a chain barrier controlled by capstans in the wall. As over 95 per cent of the vessels of the world are under 600 feet long, intermediate gates have been included in the design, dividing the lock chambers into two parts suited to vessels of 550 and 350 feet in length, respectively; these also are protected by a chain barrier. Designs for guide piers, electric towing machines, and emergency dams for cutting off the flow in case a connection is made between the high level and the level below the flight are completed or in progress.

At the site of the Gatun locks, excavation in the forebay, the lock chamber, and the trenches for the curtain walls by steam shovels, and in the lower part of the lowest lock by one of the 20-inch suction dredges, has resulted in the removal of 933,546 cubic yards of material in the dry, and 479,950 in the wet. The character of the foundations has been more fully investigated, with satisfactory results. It has been decided to give a thickness of 13 feet to the concrete floor of the locks between the upper miter sill and the sill for the intermediate gates. The work of placing old French rails for the anchorages is well under way. Plant for the construction of the lock installed and ready for operation includes unloading docks on either side of the East Diversion, the one occupied by a cement-storage shed with a capacity

of 100,000 barrels and fully equipped with electric cranes, the other with one single and two duplex cableways, supported by steel towers 800 feet apart, for unloading and storing in large stock piles sand and broken stone. The eight cubical concrete mixers are served by automatic electric cars which pass under the cement shed and the sand and stone piles, receiving sufficient material for a 2-yard batch of concrete. The mixed concrete will be handled on electric cars, and by four duplex cableways, 800 feet long, spanning the locks. Forms are to be of steel. The entire plant is operated by electricity. Supplies of suitable stone and sand for the concrete have been located and are being developed.

Since the publication of the last Annual Report, the site and plans for the Gatun dam have been subjected to a searching investigation by the Advisory Board of Engineers who accompanied Mr. Taft to the Isthmus. An abstract of their findings was published in these columns of THE ENGINEERING MAGAZINE for April last. During the year the south rock fill east of Spillway Hill was raised to elevation 58 and from this elevation material was so dumped on the upstream side as to secure the proper slope. West of the spillway spoil from various sources was dumped east of the West Diversion, through which the Chagres River now discharges, up to reference 24. The embankment inside the north rock toe was carried up to Plus 35 east of the spillway, and at the close of the year three 20-inch suction dredges were depositing material over the area between the rock piles. This fill has reached an average elevation of Plus 16. A total of 2,501,372 cubic yards of material was placed in the dam.

The excavation through Spillway Hill is practically completed and the concrete floor laid for the dam which is to support the regulating works. As soon as the side walls and floor are finished and provisions completed for the construction of the concrete dam, the earth dam will be carried across the West Diversion. This will cause the river to discharge through the spillway channel and the closing of the diversion will be the first step toward the formation of Gatun Lake. The concrete channel below the dam, 960 feet long by 285 feet wide, will have a floor varying from 1 to 4 feet in thickness, the latter near the dam, and side walls averaging 27 feet in height. The floor slopes from elevation 10 to elevation 2.2 and is laid in monoliths 30 by 20 feet. The side walls are in 35-foot sections. The regulating works will permit a discharge of 140,000 cubic feet per second when the surface of the lake is at Plus 87. During the year 359,821 cubic yards of material were excavated from Spillway Hill, practically all by steam shovels, and placed on the dam. The concrete work amounted to 30,464 cubic yards.

In the Mindi Hills section the trouble anticipated from seepage from the old French canal has not materialized and excavation in the dry has continued. One shovel is now working 32 feet below sea level or 9 feet above the completed bottom grade. The total amount removed by the shovels during the year was 615,146 cubic yards, of which 448,287 cubic yards were rock. Between Mindi and deep water in the Caribbean one seagoing suction dredge, two 5-yard dipper dredges and three French ladder dredges removed from the canal prism a total of 6,039,934 cubic yards, of which 427,005 yards were rock. Dredging done on work incidental to the canal construction amounted to 155,073 cubic yards of earth and 49,689 cubic yards were rock. At the close of the year nearly three miles of the channel from deep water were completed. Plans have been prepared for the construction of two breakwaters, in Limon Bay, 10,000 and 3,500 long respectively, for the protection of the channel from filling by wave action.

An order was made in October of last year increasing the projected bottom width of the Las Cascadas-Paraiso section of the Culebra cut from 200 to 300 feet, so that 300 feet is now the minimum bottom width of the whole Culebra section. The difficulties in this section result from the heavy rainfall, which swells the Obispo River and its tributaries to torrential proportions. Diversion channels are necessary to carry off

these waters, which bear large quantities of silt, gravel and boulders. The completion of the Camacho Diversion, taking care of the drainage on the west side of the cut, was reported last year. The Obispo Diversion, for the drainage of the east side, was completed on June 1, 1909. It entailed the excavation of about 1,132,000 cubic yards of material, two-fifths rock, and the construction of one and one-half miles of dikes. The capacity of the diversion is 6,000 cubic feet per second. Water which falls or seeps into the canal prism is cared for by pilot gravity drains in the cut itself. At the Chagres River crossing the excavation has reached grade, three feet below the low-water level of the river at Plus 43. A natural dike separates the river from the cut, but it is overtopped in time of flood. Four 24-inch pipes are to be laid through the dike, and three pumps are being installed to handle at the dike storm waters which collect in the cut and any flood waters which may reach the excavation. The top of the dike is to be raised from its present elevation of Plus 64 to Plus 70.

The total amount excavated from the canal prism during the year in the Culebra section amounted to 18,442,624 cubic yards, of which 12,291,472 cubic yards were rock. At the close of the year 43,574,954 cubic yards remained to be removed in order to complete this portion of the canal. The slides continue to be a source of annoyance. The Cucaracha slide has extended from an original length of 800 feet to 2,700 feet, involving an area of 27 acres. During the year 670,017 cubic yards were removed; it is estimated that 700,000 cubic yards are still in motion. Other slides have developed at the village of New Culebra, at old Culebra, Paraiso, and at other points. From all the slides 884,530 cubic yards were removed during the year and it is estimated that 1,000,000 cubic yards are still in motion and will eventually require excavation.

In the lake section, the tortuous course of the Chagres River, which crosses the line of the work 23 times, forms a series of peninsulas, designated, from Gamboa, Point 1, Point 2, Point 3, etc. Work on Point 1, begun February 28, 1908, was temporarily abandoned June 5, 1909, on account of flood conditions. The channel at Point 2, between Matachin and Gorgona, 2,700 feet long, 500 feet wide at the bottom, and 50 feet deep, was completed May 25, 1909, and the waters of the Chagres were turned in June 9. Of the total excavation of 1,784,459 cubic yards from this channel, 1,350,308 cubic yards were removed during the last fiscal year. Other work in progress in this section included excavations at Point 3 (begun June 12, 1909), at Caimito (1,375,599 cubic yards), at San Pablo (558,077 cubic yards to January 4, 1909, when work was temporarily abandoned), at the Cano River cut (583,867 cubic yards), and on some isolated knolls near Bohio (107,740 cubic yards).

The work done at Pedro Miguel resulted in the completion of the west lock chamber to grade, and of the east lock chamber with the exception of about 45,000 cubic yards. The total excavation was 715,726 cubic yards, of which 167,061 cubic yards were used in constructing the rock toes of the dam. The west dam will be of earth, 1,400 feet long, reference of top 105, top width 50 feet, and side slopes approximately 8 to 1. It is designed for a maximum pressure due to a head of 40 feet, and an average head of 25 to 30 feet. The dam consists of two rock piles formed of the spoil from the lock excavation, between which will be puddled clay placed mechanically and well settled by water jet. The minimum thickness at the bottom of this clay core will be 140 feet. On the east side of the lock, seepage through the pervious material will be prevented by a concrete core wall resting on rock, 550 feet long, 4 feet thick at the top, and 10 feet thick at the bottom.

Excavation at the Miraflores lock site, by steam shovels in the upper locks and by a suction dredge in the lower locks, amounted to 1,147,527 cubic yards, of which 307,060 cubic yards were placed in the toes of the dam, and 239,400 cubic yards were used in making fills. General plans for the dams have been adopted and approved during the year. The west dam, similar in construction to the

west dam at Pedro Miguel, will be connected with the lock wall and with the Cocoli Hill by concrete core walls resting on rock. Its length will be 2,300 feet, top width 40 feet at reference 70, and the side slopes approximately 12 to 1. It will be subjected to a maximum head of 40 feet and to an average head of 30 feet. The west dam will result in damming off the Cocoli River, the discharge of which will be thrown into Lake Miraflores through a diversion channel which has been cut through a depression in the adjacent hills down to reference 35. In general plan, the east dam will be of concrete founded on rock, 500 feet long, and provided with regulating works similar to, and of the same dimensions as, those at Gatun, to permit a discharge of 75,000 cubic feet a second.

The locks will be of concrete. A quarry and stone-crushing plant is being installed, a sand deposit is being developed, and a cement shed with a capacity of 75,000 barrels has been constructed. The crane plant for the construction of the lock, consisting of four berm cranes and four chamber cranes, has been contracted for but is not yet delivered.

Between Pedro Miguel and Miraflores, 1,279,600 cubic yards of material, of which 63,600 cubic yards are rock, remain to be excavated. Between Miraflores and deep water in the Pacific there remain 13,000,900 cubic yards of loam, and 1,725,000 cubic yards of rock. Because of the tidal oscillations, and the difficulties that always arise in removing rock under water, it has been decided to remove all rock between the locks and for a distance of about 2 miles below the locks in the dry. It is proposed that a temporary dam be placed about 2 miles below Miraflores locks, and that the overlying soil be removed by sluicing and dredging pumps and the underlying rock by steam shovels. This will leave below the temporary dam about 3,600,000 cubic yards of loam, and 123,000 cubic yards of rock, which will be removed by subaqueous blasting and rock breaking.

The dredge equipment during the year on the Pacific division, Pedro Miguel to deep water in the Pacific, comprised one sea-going suction dredge, one 20-inch suction and pipe-line dredge, one 5-yard dipper dredge, and four French ladder dredges. A total of 8,475,931 cubic yards of material was removed from the canal channel proper, which is now completed for about 5 miles from deep water in the Pacific.

THE GROWTH OF CAST IRON AFTER REPEATED HEATINGS.

A REPORT OF AN EXTENDED INVESTIGATION, AND A SPECIAL APPLICATION OF THE RESULTS TO THE PROBLEMS OF ANNEALING OVENS.

H. F. Rugan and H. C. H. Carpenter—Iron and Steel Institute.

THE results of an enormous amount of careful research work on the phenomena connected with the growth of cast iron after repeated heatings formed the subject of a paper presented at the recent meeting of the Iron and Steel Institute by Professors H. F. Rugan and H. C. H. Carpenter, which may fairly be considered to have been the outstanding feature of the meeting. We give below in abstract a summary of the experiments and results prepared by the authors, and a few extracts from the paper showing the practical application of the knowledge gained in this investigation to the choice of materials for the construction of annealing ovens.

A preliminary investigation was made to determine the conditions under which the maximum growth of commercial cast irons is brought about by repeated heatings. As a result, a period of four hours at 900 degrees C. was chosen for the experiments. It was shown by the preliminary investigation that for growth to take place both heating and cooling are required; a given specimen grows no more under 17 hours' treatment than under three hours'. For measuring temperature, thermo-junctions and a direct-reading pyrometer were used; for measuring changes of volume, micrometer calipers reading to 0.0001 inch. The test bars were heated in a cast-iron

muffle protected from the direct action of the flame by muffle of fire clay.

The first experiments were on three commercial cast irons. They were found to grow at different rates and to different extents, but after 94 heats they all reached a constant volume. The growths varied between 35.21 and 37.50 per cent. An increase in weight was found in all cases.

The investigation of the relation between growth and chemical composition was begun on a series of eight iron-carbon alloys containing no graphite; the carbon ranged between 4.03 and 0.15 per cent. and the other constituents were low and constant. With the sand-cast alloys, white irons, the final result in all cases was a permanent shrinkage after 39 to 78 heats, though in six out of the eight cases the shrinkage was not more than 0.5 per cent. In seven out of the eight cases, a diminution of weight was found, which followed nearly the same order as the carbon. The results with the chill-cast alloys, also white irons, were similar to those obtained with the sand-cast alloys, although the permanent shrinkage was not so fully marked. It was found that the solution of the practical problem of finding an alloy whose volume remains constant even after repeated heatings at about 900 degrees C. lies in the adoption of a white iron with about 3 per cent. of carbon and containing only small quantities of other constituents; silicon especially should not exceed about 0.2 to 0.3 per cent.

The three alloys of the high-carbon, medium-silicon series, containing small amounts of graphite and 0.5 to 0.8 per cent. of silicon, which were next investigated, grew from the outset, and reached their maximum growth in 50 to 60 heats. The bar with the lowest silicon showed the smallest, that with the highest silicon the largest, growth. Two initially white irons contracted for a certain number of heats and afterwards grew. It was found that both these irons became gray on heating and the change from shrinkage to growth was found to coincide with the appearance of free carbon (temper carbon); in the case of one of the irons the growth increased with the increase of free carbon. It was thus proved that free carbon, whether graphite or temper, is an indispensable factor in the growth of cast iron under these conditions. It is shown, however, by calculation with existing data, though these are not very satisfactory, that the growths observed in these white irons may be accounted for by an expansion consequent on the deposition of temper carbon in accordance with the equation:

$$\underset{\text{Iron carbide.}}{Fe_3C} = \underset{\text{Iron.}}{3Fe} + \underset{\text{Temper carbon.}}{C.}$$

The influence of silicon was next tested in a series of six iron-carbon-silicon alloys containing carbon 3.4 to 3.98 per cent., silicon 1 to 6 per cent. in steps of 1 per cent., and small and constant quantities of other constituents. Growths of between 15 and 63 per cent. were found, which were, broadly speaking, proportional to the silicon present and far in excess of what could be caused by the conversion of combined to free carbon. In fact, they were largest in the high-silicon alloys which contained no carbon combined with iron.

The bars used in these tests had been machined at haphazard, some from the gate, others from risers in different positions. The rate of growth was found to depend on the position. Bars cut from the gate grew more quickly than those cut from risers. That end of a bar nearer the gate grew more quickly than the other. The ends of some of the bars grew more quickly than the centres. A series of tests made on bars cut from comparable positions, all near the top of risers, showed a slower growth than that of the original bars of the iron-carbon-silicon series, but the increase in volume was ultimately about the same in both cases.

It was quite obvious from the behavior of this series of alloys that gases played an important rôle in their growth. The curves of rate of increase in weight were seen to be similar to those of growth, and established an intimate connection between the two. The final increase in weight followed the same order as the percentages of silicon. It was

found to be the resultant of three processes: a partial oxidation of carbon which diminished with increase of silicon and became nil at 6 per cent.; a probably complete oxidation of silicon, originally present as the silicide of iron, to a mixture of iron oxide and silica; and a partial oxidation of iron uncombined with silicon. The growth of the alloys of this series was thus found to be bound up with a change in the chemical condition of the silicon. In one of the alloys the gradual penetration of gases during growth was studied microscopically. It was found that large amounts of gas are dissolved at certain stages. Graphite is displaced from its original position, the spaces left are oxidised and small holes are formed. In fact, the structure is revolutionised.

Iron-silicon alloys, containing 0.65 to 2.71 per cent. of silicon and no graphite were found not to grow appreciably after repeated heatings. The influence of gases on the alloys at the two extremes of the iron-carbon-silicon series was studied in detail. The alloy highest in silicon, which grew 62 per cent. in a muffle, not only did not grow when heated in vacuo, but actually contracted slightly (0.04 per cent.). In doing so it gave up 1.11 times its volume of gas, which consisted of 87.5 per cent. hydrogen and 12.5 per cent. nitrogen. Another bar after being heated in vacuo until it had ceased evolving gas was heated in a muffle and ultimately grew 67.7 per cent. It was thus shown that the growth of this alloy is entirely due to the penetration of gases, and that the gases it originally contains have no direct share in the growth. About 47 per cent. of the penetrating gases consist of oxides of carbon. They are responsible for the oxidation of the iron silicide, which is so closely bound up with the growth of this alloy. The more rapid growth of the ends than of the rest of the bar is readily explained, as they expose more surface to the penetrating gases. The more rapid growth of the end of the bar nearest the gate of the casting is connected with the fact that it contains more dissolved gas, but the cause of it is not as yet clear.

The other alloy on which the influence of gases was investigated, that lowest in silicon of the iron-carbon-silicon series, grew 13.5 per cent. in a muffle, and 11.1 per cent. when heated to constant volume in vacuo. It gave up 1.17 times its volume of gas, which was almost exclusively hydrogen (98.5 per cent.). As regards growth in vacuo this alloy thus furnished a complete contrast to the one discussed above. The explanation suggested is that this iron, which is very close grained, does not give up all its gas on heating. Some of it remains permanently imprisoned. Its coefficient of expansion being about 400 times that of the iron when it is liberated on heating, for example, at the surface of contact between the iron and the graphite plates, the pressure will be sufficient to produce a permanent expansion. This second alloy appears to be one whose dissolved gases are capable of causing a large growth, at any rate where external gases are removed. Its growth in a muffle is probably caused by the combined effect of both originally dissolved hydrogen and the penetrating oxides of carbon. The research has thus disclosed, among the gray irons, alloys like the first of these two, whose growth in air on heating is entirely due to oxidising gases penetrating their interior, and also alloys, like the last, where this may not be the sole agent, but where originally dissolved gases contribute to some extent to the growth.

In conclusion, Profs. Rugan and Carpenter take the case of annealing ovens as a practical illustration of what takes place in the repeated heatings of cast iron. From this part of the paper we quote at length:

"These ovens are gray irons. They contain graphite and silicon, whose presence has been shown to be so intimately connected with growth. They also contain manganese, sulphur and phosphorus, whose influence has not been investigated, and must, therefore, be left out of account. They contain some dissolved gases, and they are exposed in practice to the direct action of flame gases, the influence of both of which has been carefully studied. They consist of four

main structural constituents, which may almost be considered as three:

"(1) a solid solution of iron silicide in iron and manganese; (2) graphite; (3) some combined carbon—pearlite; (4) phosphide eutectic. With repeated heating (3) tends to pass into (2). Only (1) and (2) will be considered.

"It has been shown that after the first heating gases have penetrated to a certain depth, and also that 17 hours' heating produces no more growth than three. A certain time is, of course, required, depending on the size of the oven and the rate of supply of heat, for the oven to acquire a steady temperature, and the volume corresponding to this. The author's view is that, although the gases penetrate to a certain depth during this period, possibly along slits existing between the graphite plates and the solid solution of silicide in iron, and through holes which exist here and there, yet they are not actually absorbed by the solid solution until the oven is cooling. During this absorption the oxides of carbon oxidise the iron silicide, in the first instance, at the boundaries of the crystals. This reaction is accompanied by growth and incipient disintegration. Minute cracks are formed. There may be a series of minute explosions, owing to the reaction between the dissolved hydrogen and the penetrating oxides of carbon. The mechanically weak graphite may be disintegrated and forced into holes originally existing in the metal. Nitrogen enters along with the oxides of carbon, and is absorbed to some extent. The net result is a slight growth of the oven by the time it has cooled to the ordinary temperature.

"When the oven is next heated the furnace gases penetrate a little farther, owing to the fresh avenues opened up by the reactions just described. On cooling these reactions are repeated, and in this way more of the iron is disintegrated, and a further growth takes place. Simultaneously, if the iron is close grained, like the last alloy discussed above, hydrogen and nitrogen are liberated in the interior at the boundaries between the solid solution and the graphite. Their coefficient of expansion is so much greater than that of the solids that they exert a considerable pressure, with the result that the mechanically weak graphite is disintegrated, and appears to collect in the holes of the casting. Where the boundary between two holes consists of graphite it is destroyed by this action, and the two holes become one.

"As the heats progress these changes continue. After each heat the external gases have penetrated a little farther. Finally, they work their way right through the oven, the rate depending on its chemical composition, physical texture, etc. When this condition is reached the oven has grown to its full extent. Some of the graphite has been burnt off, all the silicide of iron has been oxidised, probably to a mixture of iron oxide and silica and some iron has been oxidised as well. The main cause of growth is the disintegration of the material caused by the oxidation of the iron silicide. In close-grained irons the pressure of dissolved gases also contributes to the growth. At the conclusion of the process, the structure has been revolutionised; the oven has lost the properties of cast iron. It has no mechanical strength, and can be sawed like a piece of chalk.

"The authors have no hesitation in recommending that white irons should be tried for annealing ovens instead of gray. The most suitable composition appears to be an iron with about 3 per cent. of carbon and as few impurities as possible. Of these silicon is the most important, and should not exceed 0.2 to 0.3 per cent. This iron would probably shrink slightly on repeated heating. The reason why an upper limit of 3 per cent. of carbon is suggested is that white irons higher in carbon will tend to deposit temper carbon. Where this is the case the material will begin to grow. Even so, however, the growth will never be as much as in a gray iron. It is possible that an oven constructed of white iron may prove to be unsuitable, because it may crack on heating. Should this difficulty arise it may perhaps be overcome by modifying the design."

DISTRICT STEAM HEATING FOR CENTRAL STATIONS.

DATA OF THE ECONOMY OF UTILIZING THE EXHAUST STEAM OF CENTRAL STATIONS FOR DISTRICT HEATING.

Charles R. Bishop—National Electric Light Association.

SOME highly interesting results of district steam heating in connection with electricity supply projects are given in a paper read by Mr. Charles R. Bishop at the summer meeting of the New England Branch of the National Electric Light Association. This is a subject to which a good deal of attention is being given in contemporary periodical literature, and there are certain indications that the apathy which central-station managers have exhibited towards this entirely practical means of improving the economy of steam generating plants is giving place to a general interest in, and an intelligent appreciation of, its merits. Since the inception of the system in 1876, Mr. Bishop says, it has been adopted by central stations in over two hundred cities in the United States. The percentage of failure has been much less than that in the electric-lighting and street-railway fields. Out of 82 cities in Pennsylvania of over 5,000 inhabitants, at least 69 have central-station heating plants; and of the 51 cities of over 5,000 inhabitants in Illinois, the system has been adopted in over 30.

Mr. Bishop emphasizes the fact that the experimental period has passed and that the present development of district

RESULTS OF OPERATION OF DISTRICT STEAM HEATING IN FOUR TYPICAL PLANTS.

PLANT No. 1.

K. W. H.	Coal, Pounds.	Water, all purposes. Pounds.	Coal, Cost.	Water, Cost.
1,902,970	16,383,649	145,302,510	$21,091.82	$692.77

Oil and Waste.	Boiler Room Labor.	Engine Room Labor.	Total.	Steam Receipts.	Ave. Net Rate.
$596.36	$2,473.37	$2,008.88	$26,863.20	$37,190.35	40c.

Steam investment outside of station, including street mains, services, trenching, repaving, street traps and meters, $122,070.16.
Space heated, approximately 10,000,000 cubic feet.
Oct. 1, 1908—May 25, 1909.
Combination plant operated three seasons. City of 17,500 population.

PLANT No. 2.

K. W. H.	Coal, Pounds.	Water, all purposes. Pounds.	Coal, Cost.	Water, Cost.
541,767	6,768,661	48,131,094	$7,974.55	$463.20

Oil and Waste.	Boiler Room Labor.	Engine Room Labor.	Total.	Steam Receipts.	Ave. Net Rate.
.....	$1,029.00	.....	$9,466.75	$12,497.85	40c.

Steam investment, approximately $48,500.00.
Oct. 1, 1907—May 1, 1908.
Combination plant operated five seasons. City of 10,000 population.

PLANT No. 3.

K. W. H.	Coal, Pounds.	Water, all purposes. Pounds.	Coal, Cost.	Water, Cost.
1,087,233	12,316,000	75,556,071	$22,333.55	.....

Oil and Waste.	Boiler Room Labor.	Engine Room Labor.	Total.	Steam Receipts.	Ave. Net Rate.
.....	.....	.....	.....	$29,020.94	50c.

Electric receipts for same period, $41,112.42.
Steam investment, approximately $45,000.00
Eight heating months of 1908. Space heated, approximately 7,900,000 cubic feet.
Combination plant operated eight years. City of 10,000 population.

PLANT No. 4.

K. W. H.	Coal, Pounds.	Water, all purposes. Pounds.	Coal, Cost.	Water, Cost.
2,498,508	24,837,136	177,053,950	$15,523.21	$1,072.39

Oil and Waste.	Boiler Room Labor.	Engine Room Labor.	Total.	Steam Receipts.	Ave. Net Rate.
$370.48	$4,432.97	$2,378.86	$23,777.90	$25,931.68	27c.

Steam investment, approximately $103,000.00.
Oct. 1, 1908—June 1, 1909.
NOTE.—Steam rate should be at least 60 per cent. higher.
Space heated, about 16,000,000 cubic feet. City of 43,000 population.

BOILER AND ENGINE ROOM COSTS.

PLANT No. 1.

8,191 tons bituminous coal at $2.57½ per ton	$21,091.82	
Wages, firemen and helpers	2,473.37	
Wages, engineers	2,008.88	
Water	692.77	
Miscellaneous supplies	596.36	
		$26,683.20
Add to the above 10 per cent. for interest, depreciation, etc., on steam investment		12,207.01
		$39,070.21
Receipts from sale of steam		37,190.45
		$1,879.76
Totalized switchboard cost per K. W., including interest and depreciation on steam investment, $1,879.76 divided by 1,902,970 =		.000987 cents.

PLANT No. 2.

3,334 tons 661 pounds coal costing	$7,974.55	
Boiler room wages for 7 months	1,029.00	
Engine room wages (not given) assumed for 7 months	980.00	
Water	463.20	
Oil and waste	100.00	
		$10,546.75
Interest and depreciation at 10 per cent. on steam investment, approximately $47,650.00		4,765.00
		$15,311.75
Heating receipts		12,497.85
		$2,813.90
Totalized switchboard cost per K. W., $2,813.90 divided by 541,767 =		.00519 cents.

NOTE.—As their heat customers are heating for only about two-thirds of the previous cost to them when generating with their own apparatus, this company's rate should be 50 per cent. higher with a corresponding increase in revenue.

PLANT No. 3.

7,224 tons 399 pounds coal, including water	$22,904.05	
Wages in boiler room	2,305.45	
Wages in engine room	1,271.65	
Oil and waste	568.01	
		$27,049.16
Add to the above 10 per cent. for interest and depreciation on investment of approximately $45,000 in steam mains		4,500.00
		$31,549.16
Heating receipts		35,053.45
Surplus		$3,504.29
Note that after paying all generating charges, also interest and depreciation on investment in steam mains, there remained a totalized switchboard surplus per kilowatt hour of $3,504.29 divided by 1,081,150 =	0.324 cent.	

PLANT No. 4.

12,413 tons 1,136 pounds coal, costing	$15,523.21	
Wages in boiler room and hauling coal and ashes	4,432.97	
Wages in engine room, including oilers	2,378.86	
Water	1,072.39	
Oil and waste	370.48	
		$23,777.91
Add to the above 10 per cent. for interest and depreciation on investment of $103,000.00 in steam mains, etc		10,300.00
		$34,077.91
Heating receipts		25,931.68
		$8,146.23
Totalized switchboard cost per K. W., including interest and depreciation on steam investment, $8,146.23 divided by 2,498,508 =		.00326 cents.

NOTE.—These results being obtained while selling steam for practically fifty per cent. of what should be charged and compete with cost of fuel to individual users in that city.

heating in connection with central stations equals that of other public utilities. By slow degrees during the past thirty years the underground construction has been standardized and meters have been developed to a high degree of accuracy. While live-steam heating is profitable, exhaust-steam heating is still more profitable, and the addition of heating plant to existing electricity supply installations, without any extension of boiler equipment, will, he says, increase the value of the present investment; the number of boiler horse-power hours and,

consequently, boiler efficiency; the number of engine and generator horse-power hours and, consequently, the generator efficiency; to a remarkable degree, the proportion of heat units actually utilized to the total number manufactured; the load and power factors; the kilowatt output; the income from electric sales; and the income from plant operation. It will improve the position of the company in the competition with other companies and with isolated plants, and will result in increased net earnings and dividends. The results obtained in recent operation of four typical plants are given in the tables taken from Mr. Bishop's paper, which is printed in full in *The Electrical Age* for October.

A NEW GAS PUMP.

DESCRIPTION OF A NOVEL APPLICATION OF THE INTERNAL-COMBUSTION PRINCIPLE, WITH REPORT OF TRIALS BY PROF. W. C. UNWIN.

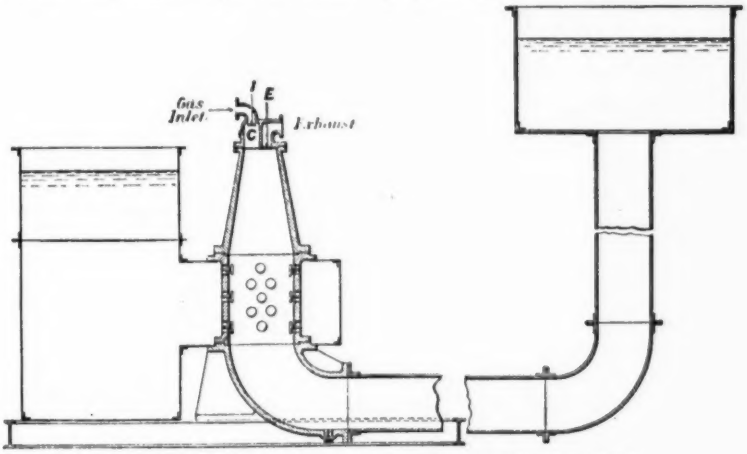
Engineering.

AN invention which may conceivably inaugurate a new era in the application of gas, not only to the pumping of water, but to the compression of air and to the driving of machinery generally, is described in *Engineering* for October 15. This is a gas pump of a perfectly novel type, designed by Mr. H. A. Humphrey, who has long been known as a leading authority on the large gas engine. Trials conducted by Prof. W. Cawthorne Unwin show so remarkable a fuel economy, with a compression of but 44 pounds per square inch, as to indicate, in the opinion of *Engineering*, that with higher compressions it should be quite practicable to pump water with this plant so cheaply that, using this water to drive a turbine, one shaft horse power should be attained for an expenditure of fuel less than is now possible by any known commercial method involving the use of gaseous fuel. We give below a brief technical description of the pump, with an abstract of Prof. Unwin's official report of the trials, which is given in full in the article mentioned.

"We reproduce a diagram showing the essential features of Mr. Humphrey's pump. It consists, as will be seen, of a U tube having legs of unequal length. The shorter leg is partially immersed in a tank, from which is drawn the water to be pumped, whilst the larger leg enters, at the bottom, the tank to which the water pumped is to be delivered. Admission-valves for the water are provided below the water-level in the suc-tank, since the pressure in the combustion-tank as indicated. The portion of this leg above the water-level in the tank forms the combustion-chamber, the valve I being the admission-valve, and the valve E the exhaust-valve. In addition to these there is a third scavenger-valve, not shown in the diagram.

"Assuming the pump to have been started, a manoeuvre which is very easily effected, the sequence of events is as follows:—A charge of gas and air entrapped in the space C is under compression, and is fired by an electric spark. This sets in motion the water in the long U leg, which forms an essential component of the pump. This water acquires a momentum so great that it continues to flow after the pressure of the gases above it has been reduced to that of the atmosphere, and at this point the exhaust-valve opens by its own weight. The column still continuing to move, water flows in from the suction-tank through the valves mentioned, partly to follow the moving column and partly to rise in the combustion-chamber, so as to keep the water-level inside the chamber nearly the same as that in the tank. There is, in fact, at this period a slight vacuum inside the chamber, so that air enters the top of it through a special automatic scavenger-valve already mentioned, with the result that the whole of the space at the top of this vessel is filled with pure air. Finally, the water column having expended its acquired momentum, begins to flow back under the static head due to the position of the delivery

tion-chamber is now atmospheric. The water which has been drawn into the system from the suction-tank is therefore forced back towards the combustion-chamber. In this backward flow it expels through the exhaust-valve the spent gases, and on reaching the level of the exhaust-valve closes it, a locking-bar coming then automatically into operation to prevent this valve opening subsequently, before its appointed time. With the momentum acquired during this period on its backward flow the column of water continues to rise, compressing the air entrapped in the space C above it, to a pressure considerably in excess of that corresponding to the static head. The result is that the motion of the column is again reversed, and fresh momentum acquired, which



DIAGRAMMATIC VIEW OF THE HUMPHREY GAS PUMP.

again causes the pressure in the combustion-chamber to fall below the atmospheric. At this moment the inlet-valve I opens, and a charge of air and gas is drawn in, whilst the water column continues its motion into the delivery tank. Finally, however, its forward momentum being again expended, it oscillates back into the combustion-chamber, compressing the charge there to a pressure which is again in excess of that due to the static head. When the desired compression is attained, the mixture is ignited, and a fresh cycle of operations is begun. The cycle, it will be seen, consists, therefore, of a long expansion stroke, in which the pressure falls to a little below that of the atmosphere, and water is drawn in from the suction-tank, and air through the scavenger-valve. This is followed by a long return stroke, during which the products of combustion are expelled. After this comes a short suction stroke, in which a fresh change is drawn in; and, finally, a short compression stroke at the end of which the charge is ignited. The pump operates, therefore, on a four stroke cycle, the strokes being equal in length. Originally a Lodge coil and plug were used to ignite the charge, as it was feared that the wetting of the plug would prevent the ordinary motor-car coil and plug being effective. It has, however, been found possible to utilise the ordinary ignition set as used in motor-car work, consisting of a couple of cells, a trembler-coil, and an ordinary plug. With this there are absolutely no misfires. Moreover, direct experiment has proved that a single missed ignition will not stop the working of the pump.

"The efficiency attained is very remarkable, and at low lifts actually exceeds that theoretically possible were the cycle the same as the Otto. The economy is, in the main, due to the utilisation of the 'toe' of the diagram, which

in the Otto cycle is, of course, wasted, since the exhaust-valve opens when the pressure in the cylinder is still 30 pounds or so above that of the atmosphere. The equivalent coal consumption with a compression of less than 45 pounds was found by Professor Unwin to be only 1.06 pounds per pump horse power hour.

"The only moving parts are the light automatic valves (which have run for a week at a time without lubrication) and the small spring-loaded piston, which times the ignition. The inlet, scavenger, and exhaust-valves are coupled up by an automatic interlocking gear. This interlocking gear is required, since all the valves operate automatically, and therefore, unless some special provision were made to prevent it, the exhaust and admission-valves would open simultaneously." This gear, and the ignition device, are fully illustrated and described in the original article.

"The combustion-chamber is always cold to the touch. Starting up the plant is quite a simple operation. After an ordinary stop made by switching off the ignition current, the combustion-chamber is left with a charge of gas and air inside it, and the pump is then restarted merely by igniting this. In a start up *ab initio* the process, though longer, is nearly equally simple. Air is compressed in above the water surface in the combustion-chamber so as to lower the water-level there to about that of the water surface in the suction-tank. The exhaust-valve is then thrown open by hand. The water column then rises in the combustion-chamber, compresses the air entrapped there, then moves back again, and draws in a charge, which is subsequently compressed and fired in the ordinary way."

From Prof. Unwin's report, which is appended to the technical description of the pump, we take a few data of the results of the trials. Owing to the small capacity of the gas holder, the runs were necessarily intermittent. In all, twelve trials were made, the first six being of ten minutes duration, and the last six of twelve minutes. Prof. Unwin gives mean values for the results of Trials I to VI, VII to IX, and X to XII. In the following table are combined the essential data contained in four tables in the original report.

MEAN VALUES, RESULTS OF TRIALS OF A HUMPHREY GAS PUMP.

	Trials I to VI.	Trials VII. to IX.	Trials X to XII.
Water Lifted.			
Head over orifice, feet	3.89	3.63	4.52
Volume pumped, cubic feet per second	4.331	4.185	4.666
Volume pumped, gallons per minute	1621	1567	1749
Mean lift in feet	32.87	25.95	20.727
P. H. P., actual horse power in water lifted	16.15	12.320	10.990
Cycles per minute	13.8	11.8	11.4
Gallons pumped per cycle	117	133	153
Gas Consumption.			
Gas used per minute corrected to dry gas at 760 mm. and 0 degrees C., cubic feet	22.368	18.663	17.143
Gas used per hour per P. H. P., cubic feet	83.12	90.93	93.61
Heat Expenditure.			
Calorific value of gas, B. Th. U. per cubic foot	147.29	143.45	145.26
Heat expended per P. H. P. per hour, B. Th. U.	12243	13037	13596
Pounds of anthracite in producer per P. H. P. per hour	1.063	1.132	1.180
Pressures in the Explosion Chamber.			
Average compression pressure, pounds per square inch	44.7	33.2	19.8
Average explosion pressure, pounds per square inch	100.1	79.6	86.4

In general comment on the pump trials, Prof. Unwin says: "The absence of mechanism and attendant friction and wear, so that there is no need for lubrication except for the very small and light interlocking gear, must have the consequences that the apparatus is exceedingly durable, and the working expense extremely small. There can be no gradual loss of efficiency such as in ordinary engines arises from piston wear and consequent leakage. As all parts of the explosion chamber are washed by water every cycle, there is no possibility of pre-ignition troubles; also the temperature of all the metal is kept low by internal water cooling, and difficulty from expansion and contraction is eliminated. The maximum lift appears to depend solely on the length of the discharge pipe. The pump

works at lower lifts automatically without any change and with no considerable change of efficiency.

"An ordinary gas engine of three times the power, and using similar gas, would use at full load 72 to 84 cubic feet of gas per brake horse power, and 95 to 100 cubic feet at half full power. If set to drive any form of pump, the gas consumption, reckoned on the pump horse power, would be considerably greater. The Humphrey pump when lifting water works with about the economy of a gas engine driving itself only."

A gas engine driving a centrifugal pump required to do 16 pump horse power on a lift of 33 feet would require 120 to 127 cubic feet of gas per pump horse power per hour; the consumption of the Humphrey pump is 83.1 cubic feet. Trials of steam pumping engines of the highest class in Prof. Unwin's experience have shown a coal consumption per pump horse power per hour varying from 1.622 to 1.996 pounds; the coal consumption of the Humphrey pump is 1.06 pounds. "The fuel consumption in the trials of the latter," Prof. Unwin says, "reckoned on the work done in lifting water, was less that in any pumping arrangement, either by gas or steam, hitherto recorded."

STEEL BELTS FOR POWER TRANSMISSION.

THE TECHNICAL AND ECONOMICAL ADVANTAGES OF STEEL BANDS FOR POWER TRANSMISSION OVER ROPES AND LEATHER BELTING.

J. P. Schroeter—Engineering News.

THE efficiency of flat steel bands for the transmission of power, a system placed on the market over two years ago by the Eloesser Kraftband Gesellschaft, of Charlottenburg, Germany, has been investigated recently at the Technische Hochschule in Charlottenburg. The results show a remarkably high slip efficiency (99.5 per cent.) and a striking economy in both first and operating costs over rope and leather-belt transmission. An abstract of a report of the results of the tests is contributed by J. P. Schroeter to *Engineering News* for October 14, which we reproduce almost in full.

"It is well known that leather belts and hemp and cotton ropes are very badly affected by atmospheric conditions. They are organic materials and, in accordance with the aim of the modern designer, should be eliminated, if possible, and replaced by inorganic materials with more uniform properties. Wire ropes are only acceptable for long-distance power transmission. We know that the slip of belts and ropes is large, that the tension must be regulated very often and that the pulleys are large, taking much space and making the whole machine heavier and more expensive. The percentage of lost power is sometimes very considerable. The steel band does not show these disadvantages. It is not influenced by atmospheric conditions, an adjustment is very seldom necessary, the slip does not exceed a maximum of 0.15 of 1 per cent., the efficiency is always above 99 per cent. and the width of the pulley is considerably decreased, diminishing the space needed and saving material.

"With the steel-band transmission, the distance between the pulley axles may be decreased, even until the pulleys almost touch, making it possible to use steel-bands to replace gears. The bands show no lateral vibrations and may be used at any velocities up to the highest met with in modern practice. This transmission has been used and practically tested abroad for several months.

"According to the official tests made at the Technische Hochschule, Charlottenburg, with steel-bands 23 millimetres wide and 0.3 millimetres thick, the useful tension per centimetre of width was 15 kilograms with pulleys 1,250 millimetres in diameter having a peripheral velocity of 15 metres to 30 metres per second; the useful tension was 10 kilograms for pulleys 600 millimetres in diameter running at a peripheral velocity of 15 metres per second. The pulleys

had a thin cork cover and the tension was very carefully adjusted to the most favorable conditions. Expressed in English units, these results may be summarized as follows:

	I.	II.
Belt width, inches	.906	.906
Belt thickness, inches	.0118	.0118
Pulley diameter, inches	49.21	23.62
Peripheral speed, feet per second	50 to 100	50
Effective pull per inch of width, pounds	84	56
Effective pull per square inch of cross section, pounds	7,112	4,742

"In practice there has been transmitted, with a steel-band of the above size, 145 horse power; and, with one 100 millimetres wide, 250 horse power.

"There is practically no noise either at high or low velocity, and in the tests it was impossible to find any elongation of the band. Its lightness and high tensile strength permit its use at higher velocities than are permissible with belts, and its use with generators and motors has proved very successful.

"An item not generally given enough consideration in calculations is the power lost in transmission. The accompanying table gives the first cost, efficiency and operating expenses with steel-bands and belt transmission."

FIRST COST, FRICTION LOSSES AND OPERATING EXPENSES FOR STEEL-BAND TRANSMISSION OF 100 HORSE-POWER.

First Cost.	Rope.	Leather.	Steel.
Pulleys	$177.00	$96.00	$60.00
Belting	148.00	310.00	180.00
Total	$325.00	$406.00	$240.00
Losses.			
Loss in per cent	13	6	0.5
Loss in horse-power.	13	6	0.5
Loss per annum in horse-power hours.	39,000	18,000	1,500
Money loss	$663.00	$306.00	$25.05
Yearly expenses.			
5 per cent interest on first cost	16.25	20.30	12.00
10 per cent depreciation on pulleys	17.70	9.60	6.00
20 per cent depreciation on belting	29.60	62.00	36.00
Friction loss as above	663.00	306.00	25.50
Total yearly	$726.55	$397.90	$79.50

NOTE.—Diameter of pulleys, 3.28 feet; distance between axes, 32.8 feet; cost per horse-power hour, 1.7 cents; 200 revolutions per minute.

DIRIGIBLE BALLOONS AND AEROPLANES IN WAR.

A DISCUSSION OF THE TYPE OF GUN AND PROJECTILE BEST SUITED TO THEIR DESTRUCTION.

Major H. L. Hawthorne—Journal of the United States Artillery.

WHATEVER may be the individual opinion of the military value of dirigible balloons and aeroplanes, there is little room for doubt that the attempt to use air ships for purposes of offense will be a feature of the next war of real seriousness. The intense interest in aeronautics manifested by practically all the military powers is most commonly observed to lie in the direction of the development of the dirigible and aeroplane as instruments of attack; the problems of defense against these new weapons, however, are being no less carefully studied. In the *Journal of the United States Artillery* for October, Major H. L. Hawthorne emphasizes the fact that experiment has shown existing guns to be inadequate successfully to oppose the peculiar powers of air ships. His article is a suggestive discussion of one of the largest problems of defense against aerial attack.

From the viewpoint of the artillery, the dirigible balloon has the following disadvantages: great visibility and area as a target; danger of destruction through ignition of gas; danger of lessening or destruction of buoyancy by the puncturing or ripping of the envelope; danger of annihilation of personnel; danger of destruction of propulsive and controlling parts. On the other hand, the dirigible balloon possesses the ability to change its range by changing its altitude, or direction, or by a combination of these two; power to rise beyond the reach of artillery fire; and high speed, making changes of range too rapid to measure or to follow.

Numerous experiments have shown that the mere puncturing of the gas bag of a dirigible will prove to be no more harmful than an annoyance. Neither would the destruction of the propulsive and controlling parts necessarily put the air ship out of action if its buoyancy remained unimpaired. The annihilation

of its personnel would, of course, destroy the utility of the dirigible, but an offensive plan based on the selection of the crew as the sole target would leave too much to chance for success. Only by the ignition or rapid liberation of the contained gas can the air ship be successfully opposed, and weapons and ammunition for balloon fighting must be designed with this object in view.

In the construction of gun, carriage, mounting, and ammunition, the following qualities are necessary: high muzzle velocity; automatic loading and withdrawal of case; great stability of carriage; rapid and easy laying both in azimuth and elevation; all-round fire and angles of elevation up to 70 degrees; indication of flight of projectile by a smoke tracer; combination fuse, with percussion element sufficiently sensitive to insure burst on impact with the gas envelope; and contents of projectile such as to cause inflammation of supporting gas, either by heat or by chemical action.

These qualities may be regarded as common to all balloon-fighting guns, whether intended for use with a mobile army, in seacoast defenses or on board ship. There are, however, certain characteristic conditions in each of these three cases which will demand special construction of both gun and mounting. To accompany a field army, the piece must have mobility, comparatively light ammunition and simplicity of range-finding equipment; hence are imposed the conditions of small caliber, small ratio of weight of gun to carriage, fixed ammunition and shell only, and an extremely flat trajectory. No matter what caliber of weapon may be selected, the need for broad dangerous spaces must bring about the construction of long guns with high velocity, involving great pressure and speed of recoil. Major Hawthorne suggests that the desirable ballistic qualities, simplicity of mechanism and adequate mobility would be combined in a 3-pounder or, preferably, a 6-pounder gun, fifty calibers long, so mounted as to allow all-round fire and an arc of elevation from zero to 70 degrees, provided that there be high initial velocity, fixed ammunition loaded from a belt or drum, breech mechanism automatic in action throughout the cycle of loading and firing, the projectile to be shell only, provided with a smoke tracer, having thin walls, and containing a comparatively large charge of some substance of high calorific value. In the mounting should be combined the qualities of short recoil, rapid movement in elevation and direction, direct laying by sight elevations, perfect stability of carriage, and a celerity and ease of movement from point to point over a threatened area.

The choice of a projectile for balloon guns is a matter on which very diverse opinions are held. Shrapnel has the advantage of great searching effect, aid in ranging by time bursts and probable large number of perforations of the balloon envelope. On the other hand, small perforations are but slight injuries, the fuse setting would have to be changed constantly, and the larger caliber, slower rate of fire and less flatness of trajectory of the shrapnel gun in comparison with the smaller shell firer would serve largely to nullify the advantage of greater searching effect. The many sacrifices made in the selection of a large caliber weapon are apparent in the Krupp type of balloon field gun and carriage, the farthest developed up to the present.

With the recognition of the inflated body of the air ship as the principal, if not the only, proper target, designers of projectiles are seeking the best contained composition to bring about its destruction. Various methods have been devised, based upon the inflammability of the confined gas; still others contemplate the destruction of the envelope by various mechanical means. There are obvious objections to all devices dependent on probable mechanical automatic action: Major Hawthorne believes that the most certain means of destruction lie with an explosion on impact of such a character as to unite the tearing and flaming effects such as might be accomplished by a shell with a large charge of substance giving intense and prolonged heat.

In coast-defense work, or in more or

less elaborate land fortifications, certain restrictions characteristic of the use of balloon guns with a mobile army are removed. Though the piece should be able to move with a certain celerity from point to point, mobility is no longer a vital problem, and a larger gun with longer recoil and hand loading methods can be adopted, keeping always in view, however, the necessity for high speed in laying. With the larger calibers there may be considered a greater variety of projectiles, and shrapnel, designed for the principal object of destruction of the envelope or contained gas, may here find a field of usefulness. The danger of shrapnel fired at high angles of elevation to friendly troops may be eliminated by having the shrapnel filled with inflammable substances only and the body pulverized by a detonating charge, or so arranged as to bring about a final destruction of its contents after attaining its object at the target. Notwithstanding the ignorance of atmospheric conditions at high altitudes, and the serious loss of time in making constant changes of fuse setting, it must be admitted that military opinion to a large extent favors the use of shrapnel against air ships.

"The installation of balloon guns on board men of war," Major Hawthorne says, "can never be satisfactory. All the factors which make firing at air ships difficult and uncertain on land will be augmented by the instability of the gun platform, which, in this case, counts for more than when the target can move in but one plane. The single advantage lies in much less danger to friendly forces in fire at high angles. The best type of gun and mount would be a small caliber, high-velocity weapon, mounted well above the deck and designed for close hand fighting."

The aeroplane may offer more of a problem to the artillerist in war than the dirigible balloon, though it is still far behind the latter both as to sustained flight and rapidity of movement. Although it seems to manœuvre with equal facility, its flight is close to the ground, its buoyancy excess small, and its speed so limited as to be unable to face air currents of any pronounced strength. These present disadvantages may in time disappear, but there must still remain a delicacy of construction and material which suggests the best means of effecting its destruction by gun fire. Even if ruin should not follow certain slight injuries, its immediate withdrawal from the upper air becomes imperative. Thus, so far as sensitiveness to injury is concerned, it becomes an ideal target for any projectile arranged to break up into many widely dispersed fragments. The field gun above outlined, with a shell provided with a time fuse, still remains the proper weapon for any dirigible; and shrapnel as suggested for use in the seacoast balloon gun fulfils the same office.

AN ELECTRIC SHAFT FURNACE.

DIRECT REDUCTION OF IRON ORE IN AN ELECTRIC FURNACE OF A NEW TYPE AT DOMNARFVET, SWEDEN.

E. J. Ljungberg— Iron and Steel Institute.

A GOOD deal of attention has been attracted recently to an important investigation on the direct reduction of iron ore in an electric furnace of a new type, which has been in progress at the Domnarfvet Iron Works, Sweden, since early last year. In general appearance this furnace is unlike any hitherto constructed; it is very similar in design to an ordinary blast furnace in which the tuyeres are replaced by electrodes. The first trial runs were witnessed by Dr. Eugene Haanel of the Canadian Department of Mines, who has recently published a description of the plant and a detailed report of his observations. Later information of the results obtained is given in a brief paper by E. J. Ljungberg, read before the Iron and Steel Institute, from which we abstract a few paragraphs.

"For a country like Sweden, possess-

ing practically no coal mines, but numerous waterfalls, the manufacture of iron and steel direct from ore by the agency of the electric current is of much more interest than the melting of pig and scrap to make steel. At the works at Domnarfvet extensive and costly trials have therefore been made in the direct reduction of ore during this and the past few years.

"The accompanying drawing shows a furnace similar to a common blast furnace, but with three electrodes fed by three-phase alternating current at about 40 volts, 60 cycles, and 9,500 ampères, averaging 674 horse-power, instead of tuyeres. In this furnace, which has been running for 1,903 hours, there have been produced 280 tons of iron, containing from 0.95 to 3.09 per cent. of carbon.

"In the manufacture of this quantity there was used:—

	Tons.
Ore	442
Lime	24
Coke	41
Charcoal	58
Electrodes, total	6.5
Electric current (kilowatt-hours)	891,623

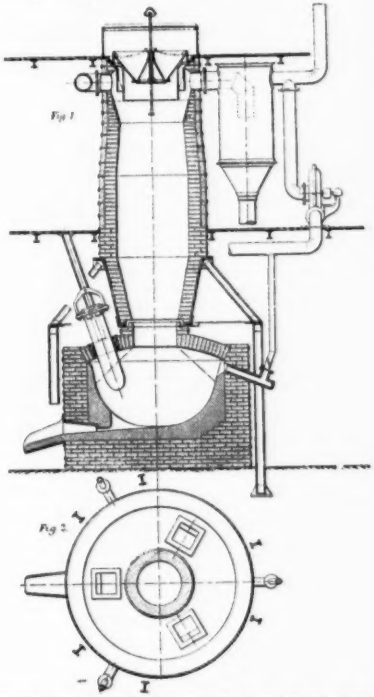
or per metric ton of pig-iron produced:—

	Kilogrammes.
Coke and charcoal	353.3
Power, horse-power year	0.492
Electrodes, effective 8.8 kgs.	
Wasted ends 13.9 kgs.	
	22.7
Pig iron from ore and lime	60.02
Pig-iron from ore alone	63.50
Pig-iron per horse-power year	2.03 tons.

"The temperature of the escaping gases from the furnace is generally very low, and they contain on an average about 22 per cent. of carbon dioxide (from 8 to 41 per cent.). The amount of carbon monoxide varies from 39.4 per cent. to 61 per cent. The gases contain practically no nitrogen, but steam from the water in the ore, lime, coke, or charcoal is present.

"The efficiency of the electric current ought to be higher than hitherto, if the considerable loss of heat by cooling water and radiation can be reduced. These losses seem to be about 30 per cent.

"No air whatever is used in the process, and the gases are produced from the carbon in the charcoal and coke and the oxygen in the ores (FeO+C=Fe+CO). Either charcoal or coke may be used, but the consumption of fuel will be practically the same in either case.



PLAN AND VERTICAL SECTION OF THE ELECTRIC SHAFT FURNACE AT DOMNARFVET.

"The figure shows a plan of, and a vertical section through, the furnace, which consists of a lower portion or smelting chamber, corresponding to the hearth of a blast-furnace, and a top section or shaft. The latter is supported on columns, which prevent any weight from bearing on the arch of the smelting chamber. The latter is so proportioned as to provide a considerable amount of free space between the charge and the arched roof through which the carbon electrodes project into the charge. The brickwork is thus protected against any very high temperature, and remains a non-conductor of electricity. This is an important feature of this furnace,

since experiment has shown that if the electrodes enter the chamber at the point where the charge touches the walls, a very high temperature is generated at this point; the brickwork is destroyed and becomes a conductor of electricity, giving rise to a more or less complete short-circuit. The brickwork may be further cooled by means of a blast of cool gas taken from the top of the furnace and blown in round the electrodes with a fan, no heat being lost by this proceeding.

"The ore and fuel are crushed to a suitable size, and are fed into the top of the furnace through the bell hopper in the usual way, the ore being partially reduced by the carbon monoxide rising through the charge. The latter spreads out in the smelting chamber as shown, and the reduction is there completed. Since the electrodes project well into the charge, the highest temperature occurs in the centre of the latter, and the brickwork is thus kept cool compared with the walls of an ordinary blast-furnace.

"It will be seen from the figures given in the paper that a step has been taken in the direction of replacing a considerable part of the fuel used in making iron and steel by the electric current, and that the problem is technically solved. As regards its commercial value, it is too early to make any definite statement yet, but this will be readily understood by all iron and steel makers when they reflect how many years it has taken to bring the Bessemer, the open-hearth, and the basic processes to their present state."

TRANSPORTATION OF COAL BY FLUME.

A DESCRIPTION OF A UNIQUE METHOD OF CONVEYING COAL IN USE IN MONTANA.

Robert M. Magraw—Mines and Minerals.

THE unusual geological conditions existing in the Cinnabar coal field of Montana have been responsible for the development of several unique methods of transporting the coal from the mines in the mountains to the coking plants located on the railway lines in the valleys. Perhaps the most interesting is a flume, one and three-quarter miles in length, conveying washed coal from the mines at Aldridge to the bunkers at Electric, a description of which is given by Mr. Robert M. Magraw in *Mines and Minerals* for November.

The flume is economical both in construction and in operation. It consists simply of a rectangular open-top box lined with sheet iron, constructed of 2-inch planking, with inside dimensions 10 by 10 inches. The lining is No. 26 gauge black sheet iron, shaped at the shops of the company to conform to the section of the flume. In laying, the iron is lapped a few inches in favor of the grade, and if kept in reasonable repair it is practically water tight.

The flume is about 9,000 feet in length, the first 3,000 feet having a grade of about 4 feet per hundred. For the next 3,500 feet, the grade varies from 15 to 35 degrees. The grade in the remaining section gradually decreases until it again becomes 4 feet per hundred. "All minor gulches are crossed on trestles constructed of 2 by 4-inch lumber, but where any marked degree of expense would have been entailed by trestling, the flume is curved to conform to the topography of the ground. No trouble was experienced with the curves or changes of grade, but when changing from a steep to a lighter pitch the flume area had to be enlarged for some little distance to allow for the swelling of volume due to the decrease of velocity." The elevation to be given on curves was easily determined by leaving the flume unnailed to stringers on all curves; after the water was turned on it was a small matter to key up the outer edge to the proper elevation.

About 50,000 feet of lumber were required per mile of flume and the cost of lumber and erection amounted to about $1,500 per mile. The cost of the iron lining per mile was about $415.80, and shaping and laying, about $75. The total cost of the flume per mile for material and construction was under $2,000,

a very good showing in comparison with the cost of a surface tram road over the same ground.

"The cost of operation of the flume is practically nil during the warmer months, but during the winter it requires the services of two men for about an hour in the morning to patrol from each end and clean out any masses of snow or slush ice which may have collected after the turning on of the water. The washer is not started during this season until the flume is reported clear. No water is allow to flow through the flume during the winter months after the washer is shut down for the day, as experience has shown that it freezes from the sides and bottom, and will close the entire flume area in a very short time. The scouring effect of the coal prevents this trouble during the shift.

"The cost of maintenance is not great, the principal item being the cost of the sheet iron. The life of the iron used will average about 2 years. Experiments contemplated for the near future are expected to determine the relative efficiency of various weights of iron, as it is thought that a heavier iron, although higher in first cost, will last proportionately longer, thereby decreasing the maintenance account an appreciable degree. It is also intended to equip a section with galvanized iron, and another section with iron of a semi-cylindrical shape." The life of the flume with very little repair is estimated at 14 years. Taking first cost into consideration, the item of maintenance is a very reasonable one.

"The capacity of the flume is, of course, governed by the volume and velocity of the water. Experience has shown that a flow of 1.58 cubic feet per second, or 63.36 miners' inches, will transport safely from 35 to 45 tons per hour on a minimum grade of 4 feet to the hundred, and this at practically no cost for operation. No accurate data are at hand showing the varying amounts of coal carried per pound of water for given grades, but the above can be taken as the maximum amount it is safe to transport with this volume of water. It would not be deemed advisable to construct a flume for the purpose of coal transportation on less than a 4 per cent grade."

THE FUEL ECONOMY OF THE DRY BLAST.

AN INVESTIGATION TO DETERMINE WHETHER THE ECONOMY OF THE DRY BLAST IS DUE TO ITS DRYNESS OR TO ITS UNIFORMITY.

Greville Jones and R. S. Moore—Iron and Steel Institute.

TWO papers read at the recent meeting of the Iron and Steel Institute deal with the results of an important investigation of the fuel economy of the Gayley dry-air blast, carried out in the Spring of the present year at the Clarence Iron Works, Middlesbrough, England. The associated investigators, Greville Jones and R. S. Moore, accept as fully established the technical and commercial economy of the Gayley process; they confess only to a doubt as to whether the principal saving in fuel is due to the dryness of the blast or to its uniformity. It was to settle this point that their experiment was undertaken. The results prove, at least to the satisfaction of the investigators, that it is to the absence of moisture from the blast that the economy must be attributed.

The experiment, which is described in Mr. Jones' paper, was carried out at one of two furnaces working side by side, both of the same dimensions, both supplied with the same quantity of air by separate blowing engines, with the same stove equipment, drawing their ore, limestone and coke from a common supply, and both burdened for foundry iron and carrying the same total load. The silicon in the iron was required to be between 2.50 and 3 per cent. The experiment was continued for four weeks, the first week being occupied in increasing the moisture up to the desired quantity. After careful observations had been made with wet and dry

bulb thermometers outside the engine house prior to the commencement of the experiment, it was agreed that it would be better not to exceed 4 grains of moisture in the aggregate.

"The procedure was to connect up to the cold-blast main a steam pipe from the main boiler plant, and fit it with a calibrated steam valve, so arranged that for a minute movement of the valve a certain quantity of steam would be admitted, representing so many grains. A pipe was also connected from the cold-blast main into a wooden case, where a wet and dry bulb thermometer was hung, with, in addition, an ordinary hair hygrometer, the instrument having previously been calibrated. There was also a connection from the hot-blast main to a wet and dry bulb, which gave an additional check. As a further check upon these instruments, the head chemist of the works very carefully took samples of both hot and cold blasts gravimetrically for five hours each day. The gases were also taken daily over the same period."

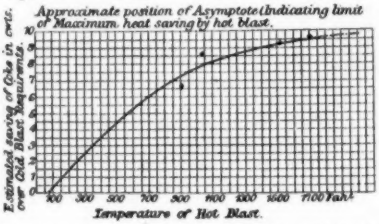
In a series of five curves, Mr. Jones gives complete data of the records of the hair hygrometer in the hot blast, the extent of opening of the steam valve, records of the air outside the engine house, and the silicon and sulphur in the product, over the whole period of the test. A number of tables give results of comparison of hygrometers, gas analyses, and calculations of heat development and absorption. Beyond the presentation of this graphical and tabular matter, Mr. Jones' observations on the experiment are very few. He notes that no appreciable difference was observed in the working of the two furnaces. The percentages of silicon and sulphur in the pig produced in the furnace on which the experiment was made were 2.97 and 0.037, respectively, before the experiment, and 2.76 and 0.036 during the experiment, showing a reduction of 0.21 per cent. in the silicon and a negligible reduction in the sulphur. The corresponding percentages for the other furnace were 2.89 and 0.045 before the experiment, and 2.84 and 0.040 during its progress. Both furnaces worked under uniform conditions of burden and blast. The record of coke consumption per ton of pig iron in the furnace used for the experiment was as follows:

	Hundredweights.
Four weeks previous to experiment	21.98
Four weeks during experiment	22.08
Four weeks after experiment	21.86

For the other furnace the record of coke consumption was:

	Hundredweights.
Four weeks previous to experiment	22.06
Four weeks during experiment	22.20
Four weeks after experiment	21.80

More extended comment on the results is made by Mr. Moore, whose paper we reproduce in full. "The results of the test," he says, "point strongly to the fact that the great heat saving of the Gayley dry blast must be due to its dryness. The theoretical explanations on this basis have not been supported by any actual experimental proof, and they have apparently been as much rejected as accepted. The principal experimental proof which is lacking is data on the saving of fuel to be secured by adding heat to the bosh. In studying the conclusions suggested by the test it occurred to the author that this hiatus is supplied by the results of experience with the Neilson hot blast.



CURVE OF RELATION BETWEEN TEMPERATURE OF HOT BLAST AND ESTIMATED SAVING OF COKE.

"Above is shown a curve representing the relation between temperature of hot blast and coke saved based on cold-blast requirements, the data for the points from which this curve is plotted being taken from Sir Lowthian Bell's book on 'The Principles of the Manufacture of Iron and Steel.' A curve which represents the variations of coke consumption with heat added to the blast also represents the combined effect of all physical and chemical changes tak-

ing place in the blast-furnace, whether the heat changes have to do with carbon monoxide reduction, the carbon reduction, or the heat absorbed by the iron, the slag, or by heating stock. It is therefore a curve of practice rather than of theory, in so far as it is accurately plotted.

"It is evident from the slope of the initial portion of the curve that a saving of 1 hundredweight of coke is obtained for approximately each 100 degrees F. increase of blast temperature. The heat added in the blast per 100 degrees per ton of iron is 276,000 British thermal units; 154,000 British thermal units are required per ton of iron to disintegrate 1 grain of moisture per cubic foot in the blast. This heat is therefore equivalent to 154,000 ÷ 276,000 = 0.56 hundredweight on the initial portion of the curve.

"But the saving in the upper portion of the curve is less than ½ hundredweight per 100 degrees F., and the question now arises what portion of the curve applies to the heat necessary to disintegrate moisture? It is a well-known fact that for the economical reduction of iron oxide in the blast-furnace as large a proportion as possible must be reduced by carbon monoxide.

"Now, as this reduction occurs most readily at about 1,100 degrees, and decreases rapidly at higher temperatures, and as the temperature of the stock entering the furnace soon approaches this point, it follows that a limit to the amount of heat which should escape in the gases rising from the bosh is soon reached. It was pointed out by Sir Lowthian Bell years ago that the economy of the Neilson hot-blast was due to the fact that adding heat to the blast enabled it to supply much of the heat necessary in the bosh to melt the iron and slag. The heat which was thus absorbed did not have to pass through the upper carbon monoxide reducing zone, thereby heating it and retarding the reduction.

"Now the heat which the iron and slag require is only about 18 per cent. of the total; it appears self-evident, therefore, that the fewer heat units which are added to the blast, the easier it is for the iron and slag to absorb them before they pass out of the bosh; but as the 18 per cent. is approached, more and more escape to the reduction zone. Therefore, removing the moisture before it enters the furnace is equivalent to utilising all the heat necessary to disintegrate it in melting the iron and fusing the slag. The economy to be expected from low moisture alone is therefore that represented by the initial portions of the curve, or 1 hundredweight of coke for 100 degrees F. temperature of blast, or, as pointed out before, 0.56 hundredweight per grain of moisture per cubic foot. If 5 grains be taken as the average amount of moisture which can be eliminated, this would be equivalent to $5 \times 0.56 = 2.8$ hundredweight; $2.8 \div 20 = 14$ per cent. of 20 hundredweight per ton of iron.

"About 2 grains of moisture were added to secure uniformity, and no gain or loss was found except a very slight lowering of the silica, indicating that the harmful effect of the 2 grains added was almost neutralised. If it be assumed that the heat gain due to uniformity is equivalent to one-half of this, or to the effect of 1 grain, the foregoing considerations would account for a saving of about 17 per cent. of fuel for dry blast. It may be said that a saving of 2.8 hundredweight on 28 hundredweight coke consumption on cold blast is not necessarily equivalent to a saving of 2.8 hundredweight on 20 hundredweight hot-blast consumption.

"There must, of course, be some difference, but it is probably very slight, because, while under cold-blast consumption 40 per cent. more coke is burned than under hot-blast, 50 per cent. more ore is contained in the furnace under hot-blast conditions. Therefore, while there is less carbon monoxide generated, it acts on 50 per cent. more ore, and under better conditions of efficiency—namely, lower temperature. The rate of increase of ore volume to coke volume is also approximately twice as great per hundredweight of coke decrease at 20 hundredweight hot-blast consumption as at 28 hundredweight cold-blast consumption. The coke saving in the two cases should therefore be closely similar."

ELECTRIC TRAIN LIGHTING ON EUROPEAN RAILWAYS.

A REVIEW OF THE SYSTEMS IN USE AND THE EXTENT OF THEIR APPLICATION.

Max Buttner—Association of Car Lighting Engineers.

SYSTEMS of electric train lighting have been developed on European railways quite independently of, and uninfluenced by, practice in the same field in the United States, but the final results have been, in the main, identical. The competition of gas lighting systems has been very keen and the introduction of electricity has been, so far, on a comparatively small scale; but Mr. Max Buttner, who has read a paper reviewing European systems and the extent of their application before the Association of Car Lighting Engineers, abstracted in the *Railway and Engineering Review* for October 23, has no doubt that electric lighting will ultimately be the winner in the fight for supremacy.

Electricity has supplanted gas for car lighting on all, or nearly all, the lines of the State railways of Switzerland, Denmark and Italy. Less extensively, but still on a very large scale, it has been adopted on the railways of Roumania, Turkey and Hungary. In England, about 8,000 cars are lighted by electricity, and in Belgium, about 1,300. Electric lighting has been introduced partially on the Northern and Paris-Orleans Railways of France. In Russia, most of the cars are still lighted by candles, but electric illumination has been adopted to about the same extent as gas.

Almost without exception the railways of Germany and Austria still cling to gas. In Germany the postal authorities and some of the small private railways are pioneers in the use of electricity, and about 2,000 cars, 1,600 of them mail cars, have been equipped with electrical apparatus. Still smaller application of the electric system has been made on the railways of Sweden, Norway, Spain, Servia and Portugal.

European railways have adopted the three systems of electric car lighting in use in the United States, the head-end system, the straight battery system, and the axle lighting system. In the head-end system three different arrangements are adopted in America; the generator may be erected on the locomotive and driven by a steam turbine; the generator may be located in the baggage car and driven by a belt from the car axle; or the generator may be located in the baggage car and driven by a steam turbine which receives its steam from the locomotive. The last of these three arrangements is the one most popular in the United States but it has found no application whatever in Europe. In every case where steam motors have been erected in baggage cars special boilers are installed beside them to supply them with steam. The principal arrangements of the head-end system in use in Europe include the installation of a steam engine or steam turbine on the locomotive, axle drive, straight battery system mounted in the baggage car, generator driven by petroleum motor in the baggage car, and generator driven by a steam turbine with boiler equipment in the baggage car.

The installation of steam engines on locomotives, after the system of Pieper and L'Hoest, has been practiced on the Belgian State Railways for many years. The Prussian railways have had about eight years' experience with the Laval steam turbine installed on locomotives and have found the system perfectly reliable. The high first cost of the system for few trains and long runs, however, has stood in the way of its extensive adoption. Apart from the excellent operation of the Laval turbine, the technical success of the arrangement has resulted chiefly from the employment of iron-wire resistances in place of automatic regulating apparatus, a system first introduced on the Prussian railways. The resistance is either put in circuit before each lamp, or, for lamps which are operated by one switch, the resistances are connected up before each group of lamps. With these resistances it is possible to put the battery on charge while the lamps are burn-

ing without making use of an automatic regulating apparatus, and without making it necessary for the engineer to pay any attention to the lighting equipment after once starting the generator, an item of great importance for the safety of the service.

When the Prussian railways decided, for economic reasons, to discontinue the installation of lighting apparatus on the locomotive, the system chosen involved the mounting of a dynamo sufficiently large to supply energy for the illumination of the whole train on the axle of the baggage car. Later, still further to lower the cost of installation and maintenance, belt drive was adopted, but, instead of employing one dynamo of 20 horse power for the whole of the train, two dynamos, each of 7 horse power, were mounted on the truck of the baggage car. The reduction in the capacity was made possible by the introduction of the metallic-filament lamp. The iron-wire resistances are exactly the same for both systems, so that both can be employed at the same time on the same line. Each car is provided with a battery.

This system has been adopted for a number of local trains of the Paris-Orleans Railway; 43 baggage cars have already been equipped. The Chemin de Fer de Ceinture de Paris is installing the system in 28 baggage cars. On these lines the dynamos are mounted inside the cars, and the batteries, instead of being mounted separately under each of the cars, are all located in the baggage cars with the remainder of the equipment. The Anatolian Railway has adopted this system for lighting its local line in Haidar-Pacha and it has found a wide application on local lines in England. It is, in fact, especially suitable for branch lines and secondary roads.

The straight battery system of head-end lighting has been adopted exclusively on the Danish State Railways, and less extensively on the Swedish private railways and the Prinz Heinrich Railway in Luxemburg. In the Swedish and Luxemburg applications only one battery, situated in the baggage car, is employed. On the Danish lines, batteries are installed in the first and last cars of the trains. The batteries are charged from stationary plants at terminals.

The petroleum-motor drive is employed chiefly on the Russian railways. Direct-connected units are installed in seven cars of the Russian South West Railway for service between St. Petersburg and Odessa. Belt drive is employed on the other roads, the Wladikawkas Railway, the East Chinese Railway, and in the cars of the International Sleeping Car Company running between St. Petersburg and Warschau. On the Siberian railways there are about ten trains similarly equipped, and the four royal trains of the Czar are lighted on the same system. Other railways, such as the Moskow Archangelsk Railway, have Laval turbines in the baggage cars with special steam boilers.

The most considerable difficulty in the general introduction of the head-end system in Europe lies in the fact that there are very few trains on European railways which are made up of the same car units for the whole of a run. In Russia, where the changing of cars is less frequent, conditions are most favorable to the head-end system, and there it has come into most general use. It is scarcely to be expected that in Europe the system will ever find considerable employment in long-distance traffic; its use will be limited principally to local lines. In general, single-car illumination will predominate.

The straight battery system is used very extensively in Europe. Against its many unquestionable advantages, the only serious disadvantage is its dependence on stationary charging stations, but this is sufficient to limit its use to certain routes on which sufficiently long stops are made to permit of regular charging at certain intervals. The constant voltage of the current supplied by the system adapts it to the use of metallic-filament lamps. "In Europe, with working voltages of 50 to 65 volts, the batteries are always installed with cell switches or with series resistances, so that all damage to the lamps is excluded. The employment of such high voltages is, however, only to be recommended

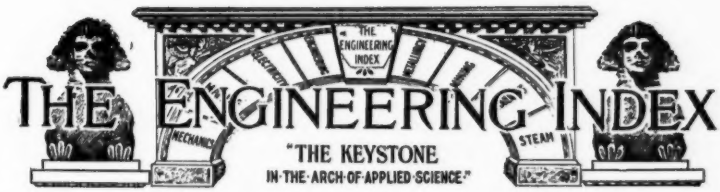
with the head-end system, when the regulation can be done by the train staff during the run. In this manner the Swedish private railways employ 28 cells for 50 volts and the Danish railways 36 cells for 65 volts, by making use of suitable resistances. For single-car lighting all regulation during the run is naturally excluded, and in this case only low voltages of 16, 24 and 32 volts are used, with batteries of 8, 12, and 16 cells. As lamp voltage, that pressure is taken which corresponds to the initial discharge voltage of the battery, 2 volts per cell. At these low pressures the loss of voltage is considerably less noticeable at the lamps than is the case with high voltages."

Straight battery lighting was introduced as early as 1887 on the Jura-Simplon Railway in Switzerland and on the North Milan Railway in Italy. In 1892 the Danish State Railways followed the example of the Swedish West Coast Railway in installing the head-end battery system. Besides the Danish railways and a large number of private Swedish lines, the Italian State Railways have adopted single-car accumulator lighting on a large scale, using batteries which are removed from the cars to be charged. The straight battery system is applied to nearly all the mail cars in Germany and to a great number in Austria, and on a less extensive scale to the cars of the Hungarian railways and the German secondary lines. The system is in every way suited to general introduction; the more general the system becomes and the more charging stations are erected, any difficulties which now exist will become less apparent.

The number of systems in which the generator is driven from the car axle is very large. Those most generally employed include the Stone system, the Aichele-Kull system of Brown, Boveri and Co., the Dick system of the Austrian Siemens-Schuckert Works, and the system of the Gesellschaft für elektrische Zugbeleuchtung. The dynamo is either suspended from the body of the car or hung on the truck. Belt drive is employed exclusively. Experiments on other driving systems have been made by the Prussian State Railways but the belt drive has been found superior.

Switching and regulating apparatus are of a variety of types. In some systems (Stone, Grob and others) the pole changer is employed as a special switch and is influenced by the centrifugal governor, which serves other switching and regulating purposes also. In other systems (Dick, Vicarino, Tudor, etc) inversion of the brushes is adopted. Reversal of the poles takes place electrically in the Aichele-Kull and G. E. Z. systems. The latter employes the Rosenberg generator which supplies current always in the same direction, whatever the direction of rotation. In the Stone, Grob, and Mather and Platt systems the automatic cut-out is operated by the centrifugal governor; the other systems employ electro-magnetic switches.

Numerous solutions have been offered to the problem of voltage regulation, the greatest difficulty in axle lighting. In the Stone system the driving belt is allowed to slip when a certain number of revolutions per minute has been attained, so that the generator speed remains constant, whatever the speed of the train. The most popular method, however, consists in varying the intensity of the field, which is accomplished either by automatic regulation of the exciting current or by the use of a second field winding through which the main current is led, which counteracts the primary winding. The exciting current is regulated by switching in resistances (Aichele-Kull and Dick systems) or by means of counter electromotive force (Dalziel system). In the Rosenberg generator, a special arrangement of short-circuited brushes and a special magnet construction keep the voltage constant. The second field winding is used in the Vicarino and Tudor systems. The Grob system makes use of a third method; the generator has two commutators, one for lighting voltage, the other for battery voltage, with separate excitation by a battery. The Stone, G. E. Z., Tudor and Vicarino systems work with constant current, the Aichele-Kull, Dick and Grob systems with constant voltage.



The following pages form a descriptive index to the important articles of permanent value published currently in about two-hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,
(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

DIVISIONS OF THE ENGINEERING INDEX.

Civil Engineering	449	Mechanical Engineering	464
Electrical Engineering	456	Mining and Metallurgy	475
Industrial Economy	461	Railway Engineering	482
Marine and Naval Engineering	462	Street and Electric Railways	485

CIVIL ENGINEERING.

BRIDGES.

Arches.

Simplified Calculation of Rigid Arches on the Elastic Theory (Vereinfachte Berechnung von eingespannten Gewolben nach der Elastizitätstheorie). S. Sor. Mathematical demonstration of method. Ills. 2200 w. Beton u Eisen—Sept. 1, 1909. No. 8696 F.

Concrete.

Concrete in Important Railroad Work. James W. Phillips. Illustrated account of its utility in abolishing grade crossings of the Philadelphia & Reading Ry. in Philadelphia. 1200 w. Cement Age—Oct., 1909. No. 8753.

Design.

The Calculation of Stresses in Stiffening Trusses. F. E. Turneaure. An appendix to the report by Ralph Modjeski on the Manhattan Bridge. Gives the derivation of formulæ. 1200 w. Eng Rec—Oct. 9, 1909. No. 8438.

Drawbridges.

Swing Bridge Across the Weaver Navigation. Illustrated description of a struc-

We supply copies of these articles. See page 487.

ture chiefly noteworthy on account of the novel arrangement of the ball-bearing pivot on which it swings. 1200 w. Engr, Lond—Oct. 8, 1909. No. 8939 A.

The Kaiser Wilhelm Swing Bridge at Wilhelmshafen, Germany (Le Pont Tournant Kaiser Wilhelm à Wilhelmshafen, Allemagne). Illustrated detailed description. 1800 w. Génie Civil—Sept. 11, 1909. No. 8630 D.

Live Loads.

Digest and Criticism of the Published Investigations on the Oscillations of a Beam under a Rolling Load (Darstellung und Kritik der in der Literatur vorliegenden Untersuchungen über Schwingungen eines Trägers mit bewegter Last). Edmund Bühler. Mathematical. Serial. 1st part. 5000 w. Glasers Ann—Sept. 1, 1909. No. 8681 D.

Manhattan.

The Design and Construction of the Manhattan Bridge. A summary of the Manhattan bridge report by Ralph Modjeski, wholly favorable to the structure. 3500 w. Eng Rec—Oct. 2, 1909. No. 8234.

Modjeski's Report on Design and Construction of the Manhattan Bridge Over the East River at New York City. Full report, with illustrations, favorable to the structure. 7500 w. Eng News—Oct. 14, 1909. No. 8564.

Reconstruction.

Reconstruction of Approach Spans, Poughkeepsie Bridge. Describes reconstruction work made necessary by traffic requirements. 2200 w. Eng Rec—Oct. 9, 1909. No. 8436.

Reinforced Concrete.

Highway Bridge over a Canal in Ravensburg (Strassenbrücke über den Schussenkanal in Ravensburg). H. Pilgrim. Mathematical description of a bridge of 6.8 metres span. Ills. Serial. 1st part. 2300 w. Beton u Eisen—Sept. 1, 1909. No. 8695 F.

See also Floods, under WATERWAYS AND HARBORS.

Replacement.

Replacing a Lehigh Valley Railroad Bridge. Illustrated account of bridge 444 A on the Buffalo Division which was erected without interruption of traffic of any of three railroads concerned. 1000 w. Eng Rec—Oct. 16, 1909. No. 8593.

Steel.

Stresses in Transverse Beams Rigidly Connected to Horizontal Girders (Nebenspannungen der Querträger infolge steifer Längsträgeranschlüsse). Ivan Arnovlevic. Mathematical. Ills. 2000 w. Oest Wochenschr f d Oeffent Baudienst—Sept. 18, 1909. No. 8694 D.

Timber.

A Recent All-Wood Truss, Railroad Bridge. Illustrated description of a through-truss bridge, on B. & M. R. R., of about 100 feet clear span. 1800 w. Eng Rec—Oct. 23, 1909. No. 8703.

Viaducts.

Erection of the Fades Viaduct. Illustrated description of a railroad viaduct in France, notable for the exceptional height of the masonry pillars, and the length of the central span. 1000 w. Sci Am—Oct. 9, 1909. No. 8412.

See also Elevated Railways, under PERMANENT WAY AND BUILDINGS.

CONSTRUCTION.

Beams.

A Note on the Deflection Due to Shear. W. C. Popplewell. Gives a method of determining the deflection due to shear as separate from that due to direct stresses. 1800 w. Engr, Lond—Sept. 24, 1909. No. 8367 A.

Chalmette Monument.

Work of Completing Chalmette Monument. An illustrated account of the work of completing an abandoned monument erected to the honor of Andrew Jackson, and those who lost their lives in the great battle. 3000 w. Jour Assn of Engng Socs—Sept., 1909. No. 8767 C.

Earthquake.

Report of the Jury in the Competition on Earthquake Construction Recently Held in Italy (Relazione della Giuria del Concorso per Costruzioni edilizie nelle Regioni Italiane soggette a Movimenti sismici). Serial. 1st part. 4000 w. Monit Tech—Sept. 20, 1909. No. 8638 D.

Excavators.

The Van Buren Excavator. Illustrates and describes a machine for digging trenches, canals and railroad cuts. 1500 w. Ir Age—Oct. 7, 1909. No. 8373.

Factories.

Reinforced Concrete for Factory Construction. J. P. H. Perry. Address before the Machine Tool Builders' Association, showing the value of this material for such plants. Ills. 4000 w. Ir Age—Oct. 21, 1909. No. 8779.

Fireproof.

Fireproof Theatre Construction (Feuersicherheit der Theater). Refers especially to the new German regulations covering the construction of theatres, assembly rooms, and such buildings. Ills. Serial. 1st part. 3700 w. Gesundheits-Ing—Sept. 4, 1909. No. 8686 D.

See also Grain Elevators, and Reinforced Concrete, under CONSTRUCTION.

Floors.

A New Type of Reinforced-Concrete Floor. Alfred Gradenwitz. Illustrated description of the Pohlmann system. 1300 w. Cement Age—Oct., 1909. No. 8754.

Costs of Constructing Combination Concrete and Tile Floors in Three Buildings. Figures given by Prof. W. K. Hatt. 1000 w. Engng-Con—Oct. 13, 1909. No. 8552.

We supply copies of these articles. See page 487.

Grain Elevators.

Grain Elevator Construction. A. C. Olds. Read before the Fire Underwriters Assn. of the N. W. On the economy of fireproof elevators. Ills. 2500 w. Ins Engng—Oct., 1909. No. 8962 C.

High Work.

Methods of Executing Light Work at Great Heights. Describes methods used in painting a cornice on a 14-story hotel in Philadelphia; of repairing tall stacks, etc. Ills. 3000 w. Eng Rec—Oct. 23, 1909. No. 8704.

Piling.

The Modern Steel Sheet Pile. J. F. Springer. History of the development and application of the earliest and modern types. 1500 w. Ir Trd Rev—Sept. 30, 1909. Serial. 1st part. No. 8225.

Reclamation Work.

The Reclamation of Wet Lands in Louisiana. Information relating to the improvement of land by levees and drainage, the methods used, etc. Ills. 2000 w. Eng Rec—Oct. 9, 1909. No. 8437.

Reclamation of the Florida Everglades. J. H. Reese. An account of the work already done, the plan of drainage, the cost, and the good to result from the reclamation. 3000 w. Mfrs' Rec—Oct. 7, 1909. No. 8385.

Reinforced Concrete.

Formulas for Designing Reinforced Concrete Beams. Melvin D. Casler. Gives formulas of different form from those commonly used, with diagram, and explanation. 1600 w. Eng Rec—Oct. 2, 1909. No. 8241.

Stresses in Reinforced-Concrete Beams. Prof. Gaetano Lanza and Lawrence S. Smith. Comparison of experimental results with results obtained from the application of three theories of distribution of stresses. 2000 w. Jour Am Soc of Mech Engrs—Mid-Oct., 1909. No. 8748 F.

Test Loading of a Pohlmann Roof to Determine the Accuracy of Certain Formulæ for the Deflection of Reinforced Concrete Beams (Die Probebelastung einer Bulbeisendecke, System Regierungsbaumeister Pohlmann, nebst Untersuchung des Genauigkeitsgrades einiger für die Durchbiegung von Eisenbetonbalken angegebenen Formeln). Ills. 4000 w. Beton u Eisen—Sept. 24, 1909. No. 8698 F.

Reinforced Concrete Joists, with Hollow Tile Fillers. J. Norman Jensen. Describes a type of construction for a fireproof floor adapted to wide spans. 2000 w. Eng Rec—Oct. 9, 1909. No. 8433.

A Concrete Church, and the Methods of Waterproofing It. Illustrates and describes methods used in erecting the Church of Our Lady of Mercy in New York City. 2000 w. Eng Rec—Oct. 23, 1909. No. 8706.

The Loeser Warehouse. Illustrated description of a reinforced concrete structure in Brooklyn, N. Y., protected with approved apparatus for detecting and extinguishing fires. 1000 w. Ins Engng—Sept., 1909. No. 8499 C.

Modern Factory Construction in Reinforced Concrete (Moderne Fabrikbauten in armiertem Beton). Hugo Grözer. A brief general discussion with descriptions of some notable structures in Austria. Ills. Serial. 1st part. 4000 w. Zeitschr d Oest Ing u Arch Ver—Sept. 10, 1909. No. 8689 D.

Car and Locomotive Shops of the Salzburg Railway and Tramway Company (Wagen- und Lokomotivschuppen der Salzburger Eisenbahn- und Tramway-Gesellschaft). Franz Böhm. Description of heavy shop construction in reinforced concrete. Ills. 2000 w. Beton u. Eisen—Sept. 1, 1909. No. 8697 F.

See also Floors, under CONSTRUCTION; and Dams and Siphons, under WATER SUPPLY.

Roofs.

Utilization of Material in Steel Roof Trusses (Zur Materialausnützung des eisernen Dachbinders). Fritz Weiss. Mathematical discussion of the most economical disposition of metal. Ills. 3500 w. Zeitschr d Oest Ing u Arch Ver—Sept. 10, 1909. No. 8690 D.

Steel.

The Design of Members Subjected to Combined Stresses. E. L. Hancock. A summary of tests made of steel under combined stresses of strain with tension, flexure and compression. 1200 w. Eng Rec—Oct. 9, 1909. No. 8432.

Statical Design of a Beam of 17.45 Metres Span (Calcul statique d'une Poutre de 17.45 m. de Portée). Herr Hattingerff. Mathematical discussion of the design of a plate girder to support an inclined reinforced-concrete roof. Ills. 4000 w. All Indus—Sept., 1909. No. 8621 D.

Temperature Stresses in the Members of Steel Structures. States facts supporting the conclusion that the heat of the sun's rays may be great enough to form an appreciable addition to the load stresses. 2000 w. Eng News—Oct. 21, 1909. No. 8821.

Structural Frames of the Open-Hearth Buildings at Gary. Illustrated detailed description of buildings of unusual structural interest. 2500 w. Eng Rec—Oct. 9, 1909. No. 8431.

The Metropolitan Tower. An illustrated detailed study of the structural features of the building from the constructor's viewpoint. Plates. 9000 w. Am Arch—Oct. 6, 1909. No. 8382 D.

The Emigrant Industrial Savings Bank Building, New York. Plans and description of problems of interest in constructing a building on the same and adjoining land, without interruption of business

We supply copies of these articles. See page 487.

in the original structure. 2500 w. Eng Rec—Oct. 2, 1909. No. 8236.

See also Roofs, under CONSTRUCTION; and Rivet Holes, and Rivetted Joints, under MECHANICAL ENGINEERING, MACHINE ELEMENTS AND DESIGN.

Tunnels.

A New World's Record of Progress in Rock Tunneling; Red Rock Tunnel, Los Angeles Aqueduct. Account by J. B. Lippincott in regard to the record made, also editorial. 2000 w. Engng-Con—Oct. 20, 1909. No. 8793.

The Great Otira Tunnel. W. Wilson. An illustrated account of a notable engineering undertaking in New Zealand. 2000 w. Cassier's Mag—Oct., 1909. No. 8461 B.

The Tunnel Under the Detroit River. Norman B. Beasley. Brief description, with illustrations. 900 w. Sci Am Sup—Oct. 9, 1909. No. 8415.

The New York Tunnel Extension of the Pennsylvania Railroad. The East River Tunnels. James H. Brace, Francis Mason, and S. H. Woodard. An illustrated article considering the construction of these tunnels. 21500 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8843 E.

The New York Tunnel Extension of the Pennsylvania Railroad. The Cross-Town Tunnels. James H. Brace and Francis Mason. Illustrated description of the construction of the tunnels extending eastward from the easterly extension of the Terminal Station to the permanent shafts east of First Avenue. 3000 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8842 E.

Waterproofing.

On Waterproofing Concrete. A brief summary of what is being done in improving methods. 2000 w. Sci Am—Oct. 2, 1909. No. 8212.

Tests of Alum and Soap Waterproofing. Abstract from the *Technograph* of tests made at the University of Illinois. 1500 w. Eng Rec—Oct. 9, 1909. No. 8441.

Foundation Waterproofing in the State Education Building. Illustrates and describes waterproofing of hydrolithic cement on a building in Albany, N. Y. 2000 w. Eng Rec—Oct. 16, 1909. No. 8509.

See also Reinforced Concrete, under CONSTRUCTION.

MATERIALS OF CONSTRUCTION.

Aspnalt.

Confusion as to Asphaltic Specifications. H. Tipper. A criticism of the specifications for paving, and suggestions from a paper by Dr. Albert Sommer. 2500 w. Eng News—Oct. 7, 1909. No. 8403.

Cement.

The Nature of Portland Cement. Edward Godfrey. Explains the nature of the substance as shown by physical tests and experience. 3000 w. Eng Rec—Oct. 16, 1909. No. 8596.

Concrete.

See Mortar, under MATERIALS OF CONSTRUCTION.

Mortar.

The Adhesion of Mortar and Concrete. R. Feret. Information concerning the adhesion to various materials, giving rules for building of structures where adhesion is of prime importance. 1500 w. Cement—Sept., 1909. No. 8506 C.

Paints.

Artificial Magnetic Oxide of Iron. F. J. R. Carulla. Read before the Ir. & St. Inst. Claiming that William Gregory first discovered the artificial production of magnetic oxide of iron, and matters relating to this productive paint. 1500 w. Engng—Oct. 15, 1909. No. 8937 A.

Excluding and Rust Inhibiting Properties of Paint Pigments for the Protection of Steel and Iron. Henry A. Gardner. Abstract of a paper read before the Mas. Car. & Loc. Painters' Assn. Aims to give new light on the subject of pigments, which will assist in selecting the proper pigments for various uses. 2500 w. Engng-Con—Oct. 6, 1909. No. 8417.

Timber.

Experiments on the Crushing Strength of Timber (Het Indrukken van Paalkoppen in Kespen). M. E. H. Tjaden. Gives detailed results of elaborate tests. Ills. 8000 w. De Ingenieur—Sept. 11, 1909. No. 8920 D.

Timber Preservation.

A Comparison of the Various Processes of Preserving Timber. G. B. Shipley. Seven processes are described and information given of the equipment for timber-treating plants, their cost, etc. Ills. 5000 w. Eng News—Oct. 14, 1909. No. 8563.

MEASUREMENT.

Cement Testing.

Progress in Methods of Testing Hydraulic Cements. Abstract of a report by M. Feret to the recent Copenhagen Congress of the Int. Assn. for Testing Materials, on some new tests proposed. 2500 w. Eng Rec—Oct. 2, 1909. No. 8235.

Measuring the Hardness of Cements by the Ball Method (Essai de Dureté des Chaux et Ciments par la Méthode de la Bille). M. Laborbe. Discusses the ball indentation test as applied to hydraulic mortars. Ills. 5500 w. Rev de Métal—Sept., 1909. No. 8608 E + F.

Current Meters.

The Use and Care of the Current Meter, as Practiced by the United States Geological Survey. Discussion of the paper by John C. Hoyt. Ills. 1800 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8847 E.

Surveying.

A Description of Four Stadia Surveys and Their Cost. Arthur W. Tidd. Describes the methods used for conducting

and systematizing the work; also giving cost data and other information. 4000 w. Eng News—Oct. 21, 1909. No. 8818.

Testing Machines.

Calibration of the 2,400,000-lb. Hydraulic Testing Machine of the Phœnix Iron Co. at Phœnixville, Pa., by Comparison with the Watertown Arsenal Emery Machine. Reports results of tests. 2000 w. Eng News—Oct. 7, 1909. No. 8404.

MUNICIPAL.

Cesspools.

The Cesspool and Its Dangers. Burton J. Ashley. Read before the Am. Soc. of Insp. of Plumb. and San. Engrs. Shows that underground waters are often polluted and that wells are contaminated. 4500 w. Can Engr—Oct. 15, 1909. No. 8792.

Drainage.

Methods and Cost of Drainage Work in Illinois. Abstract from report of Committee on Drainage, Ills. Soc. of Engrs. & Surv. Ills. 7000 w. Engng-Con—Oct. 13, 1909. No. 8553.

Experimental Data on Methods and Costs of Draining Irrigated Lands. Plans and description of the draining of Geary farm, Huntington, Utah, and also other work done, showing differences in countries having an underflow, and those underlaid with bog land. 4500 w. Engng-Con—Oct. 20, 1909. No. 8795.

See also Reclamation Work, under CONSTRUCTION; Street Grading, under MUNICIPAL; and Purification, under WATER SUPPLY.

Pavements.

A Review of Chicago Paving Practice. Discussion of the paper by P. E. Green. 5800 w. Pro Am Soc Civ Engrs—Oct., 1909. No. 8849 E.

Asphalt Paving Mixtures. L. Kirschbraun. On points relating to the construction and the materials necessary to produce a good pavement. 1800 w. Munic Engng—Oct., 1909. No. 8508 C.

Portable Machines for Making Asphaltic Concrete Paving. Illustrates and describes these machines and gives an account of work in Chicago. 5000 w. Eng News—Oct. 21, 1909. No. 8820.

See also Asphalt, under MATERIALS OF CONSTRUCTION.

Roads.

The Road Situation in the United States and Other Countries. Logan Waller Page. Read before the Nat. Road Cong. Interesting information in regard to roads and their administration and maintenance in the United States, England, France, Germany and Switzerland. 3000 w. Eng Rec—Oct. 2, 1909. No. 8237.

Macadam Roads. Austin B. Fletcher. Read before the Nat. Good Roads Cong. Considers the characteristics of the modern macadam road, their cost, the effect of automobiles, etc., giving information relating to roads in Massachusetts. 2800 w. Eng Rec—Oct. 2, 1909. No. 8240.

Dust Prevention. Report of official tests carried out by the Roads Improvement Assn. with calcium chloride. 4000 w. Auto Jour—Sept. 25, 1909. No. 8337 A.

Bituminous Road Materials. Prevost Hubbard. Read at Nat. Good Roads Con. Information concerning the material, its application, and methods of road construction. 3300 w. Engng-Con—Sept. 29, 1909. No. 8231.

Tar as Applied to the Surface Treatment of Roads. Henry J. Skinner. Read at meeting of Am. Gas Inst. An account of methods used and results obtained. 3000 w. Engng-Con—Oct. 20, 1909. No. 8794.

English Methods of Tar Spraying for Dust Prevention and Some General Costs of the Work. Gives a summary of some of the replies received to inquiries sent out by the paving committee of the London Metropolitan Borough Councils. 1500 w. Engng-Con—Sept. 29, 1909. No. 8230.

Experimental Tar Treatment on the Havel Road (Die Probeteerungen auf der Havel-Chaussee). Describes and discusses dust-laying experiments in the neighborhood of Berlin. Ills. 3000 w. Zeitschr d Mit Motorwagen Ver—Sept. 15, 1909. No. 8670 D.

Road Exhibition in Paris, 1908 (Die Pariser Strassenbauausstellung 1908). A. Liebmann. Describes an exhibit of road and pavement materials and machinery in connection with the first International Road Congress. 2500 w. Glasers Ann—Sept. 15, 1909. No. 8683 D.

Sanitation.

See Cesspools, under MUNICIPAL.

Sewage Disposal.

The Disposal of Sewage. Editorial review of the latest report of the Royal Commission. 2000 w. Engng—Oct. 1, 1909. No. 8492 A.

The Present Position of the Sewage Disposal Question. W. J. Dibdin. Read before the Inst. of San. Engrs. Remarks on the Fifth Report of the Royal Commission, and gives a report of the slate bed for the treatment of crude sewage. Ills. 3500 w. Surveyor—Oct. 8, 1909. Serial. 1st part. No. 8877 A.

A Committee Report on Sewage Disposal in the United States. Information prepared for a committee appointed by the City Council of Trenton, N. J. 8500 w. Engng-Con—Oct. 6, 1909. No. 8416.

Official Reports on Discharge of Sewage into New York Harbor. Information from the reports of Col. W. M. Black concerning the amount of sewage that may be discharged into the harbor and the proper treatment. 1800 w. Eng Rec—Oct. 23, 1909. No. 8702.

Reports by Col. W. M. Black on the Pollution of New York Harbor and the

Proposed Passaic Valley and Bronx Valley Sewer Outlets. 7500 w. Eng News—Oct. 21, 1909. No. 8822.

Some Notes on the Separation of Solids from Sewage and Waste Liquors. James P. Norrington. Read before the Incor. Assn. of Munic. & Co. Engrs. Illustrates and describes arrangements for the removal of suspended matter. Also discussion. 7000 w. Surveyor—Oct. 15, 1909. No. 8878 A.

Philadelphia Experiments in Sewage Disposal. Illustrated description of the Spring Garden Experiment Station, with an account of the work in progress. 1800 w. Munic Jour & Engr—Oct. 27, 1909. Serial. 1st part. No. 8709.

Sewage Disposal and Purification in Nagyszeben, Hungary (Die Kanalisation und Abwasserreinigungsanlage der Kgl. Freistadt Nagyszeben in Ungarn). Emerich Forbath. Illustrated discussion of the conditions and description of the sewerage installations. Serial, 1st part. 4500 w. Gesundheits-Ing—Sept. 18, 1909. No. 8687 D.

Sewage Drying.

Schaefer-ter Meers Centrifugal Machine for Sewage Sludge. Illustrated description. 1500 w. Engng—Oct. 15, 1909. No. 8934 A.

Sewers.

Some Notes on the Louisville Sewerage Improvements. Roger DeL. French. Describes the more interesting features of the work. Ills. 1500 w. Eng News—Oct. 14, 1909. No. 8566.

Early History of Sewers in Memphis, Tenn. A. T. Bell. Describes the city and the special features of the sewer system. 2500 w. Munic Engng—Oct., 1909. No. 8510 C.

Stone Crushing.

See Quarrying, under MINING AND METALLURGY, MINING.

Street Grading.

Street Grades. Discussion from report of Nelson P. Lewis of A. S. Tuttle's study of precise grades and of grade platforms at street intersections in New York City. Ills. 2000 w. Eng Rec—Oct. 16, 1909. No. 8592.

A New Method of Grading and Draining Street Intersections. William W. Marr. Gives arguments for and against the forms known as "inlet corners" and "summit corners," and describes a form which is believed to be an improvement. Ills. 1000 w. Eng News—Oct. 7, 1909. No. 8405.

WATER SUPPLY.

Aqueducts.

A Combined Water-Supply, Irrigation, and Power Project. Burt A. Heinly. An illustrated account of the plan, construction, and purposes of the Los Angeles aqueduct. 3000 w. Engineering Magazine—Nov., 1909. No. 8829 B.

Artesian Wells.

The Progress of Artesian Well Work in Dry Countries. Editorial review of what has been done in later years, in the more arid regions of the earth, to provide water from underground supplies under pressure. 2500 w. Engng—Sept. 24, 1909. No. 8365 A.

Dams.

The Construction of Concrete Dams. F. M. Hoadley. An illustrated comparison of solid masonry and hollow, concrete dams. 1200 w. Cassier's Mag—Oct., 1909. No. 8466 B.

A Hydraulic Fill Dam in South Carolina. H. Sudlow. Describes features of interest in the construction of a small hydro-electric plant near Aiken. 2000 w. Eng Rec—Oct. 2, 1909. No. 8239.

The Construction of the Barker Dam Near Boulder. Illustrated description of methods used in constructing a masonry dam having a height of 185 ft. above the foundation. 4500 w. Eng Rec—Oct. 2, 1909. No. 8233.

The Failure of the Fergus Falls, Minn., City Dam. Franklin McMillan. An illustrated account of the construction and failure of this concrete dam, caused by floods. 1500 w. Eng News—Oct. 14, 1909. No. 8561.

Repairs in Reinforced-Concrete to the Crampagna Barrage, Ariège, France (Réfection en Béton armé du Barrage de Crampagna, Ariège). C. Picot. Describes the work of closing a breach 26 metres long. Ills. Plate. 1800 w. Tech Mod—Sept., 1909. No. 8617 D.

Filtration.

The New Filtration Plant for Wilkinsburg. F. B. Leopold. Read before the Central States Water-Works Assn. Describes a mechanical filtration plant installed where unusual conditions had to be met. 2000 w. Eng Rec—Oct. 9, 1909. No. 8445.

Water Filtration Plant at Sandusky, Ohio. Detailed description of a purification plant costing about $101,500, built of concrete without reinforcement. 2000 w. Eng Rec—Oct. 16, 1909. No. 8594.

Ground Waters.

The Discovery of Subterranean Waters (Descubrimiento de Aguas subterraneas). Describes an instrument invented by P. Garcia Muñoz. 3000 w. Energia Elec—Sept. 10, 1909. No. 8645 D.

A New Method of Determining the Direction and Velocity of Flow of Ground Waters (Nuovi Metodi per Determinare la Direzione e la Velocita delle Falde Acquee alluvionali). Illustrated description. 2000 w. Monit Tech—Sept. 20, 1909. No. 8639 D.

High Pressure.

High Pressure Water Supply in London (Distribution d'Eau à haute Pression de la Ville de Londres). J. F. Audouin. De-

We supply copies of these articles. See page 487.

scribes the installations and distribution system of the London Hydraulic Power Co. Ills. 2000 w. Rev Indus—Sept. 4, 1909. No. 8623 D.

Irrigation.

Some Engineering Features of the Canadian Pacific Irrigation Project. Illustrates and describes work in Alberta. 1400 w. Munic Engng—Oct., 1909. No. 8509 C.

The Redemption of the Great Valley of California. Discussion of the paper by A. D. Foote. 2000 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8848 E.

The Standley Lake Irrigation System Near Denver, Colorado. Illustrated description of a system of extensive works for the storage of water and its delivery to about 200,000 acres of land. 3500 w. Eng Rec—Oct. 16, 1909. Serial. 1st part. No. 8590.

See also Aqueducts, under WATER SUPPLY.

London.

Extensions of the London Water-Works. H. E. Drew. Sketch map and brief description of schemes in progress. 1500 w. Eng Rec—Oct. 2, 1909. No. 8238.

See also High Pressure, under WATER SUPPLY.

Pollution.

See Cesspools, under MUNICIPAL.

Purification.

Cost of Clearing Water in Settling Basins. S. Bent Russell. Read before the Central States Water-Works Assn. An analysis of costs at St. Louis. 2500 w. Eng Rec—Oct. 16, 1907. No. 8700.

The Cost of Clearing Water in Settling Basins. S. Bent Russell. From a paper before the Cent. States W.-Wks. Assn. Considers four types of settling reservoirs, with other features and costs. 2200 w. Eng News—Oct. 14, 1909. No. 8562.

The Clarification of Muddy Waters by Natural Decantation and the Automatic Cleaning of Pump Wells (Clarification des Eaux boueuses par Decantation naturelle et Nettoyage automatique des Puisards de Pompes). A. Babonneau. Discusses the application of decantation in coal and ore washing plants, etc., where the recovery of the suspended matter is desired. Ills. Serial. 1st part. Génie Civil—Sept. 4, 1909. No. 8629 D.

House Apparatus for the Purification of Drinking Water by Ozone (Hausapparate zur Ozonisierung des Trinkwassers). Illustrated description. 1500 w. Elektrochem Zeitschr—Sept., 1909. No. 8647 D.

The Iron-Lime Process of Water Purification. From a paper by C. Arthur Brown, outlining the conditions which must be satisfied for these materials to be used successfully. 2000 w. Eng Rec—Oct. 9, 1909. No. 8435.

Building for the Future. Charles B. Starkey. Illustrated description of the water purification and drainage in the city of New Orleans, La. 2000 w. Dom Engng—Oct. 2, 1909. Serial. 1st part. No. 8291.

Water Purification at Reading, Pa. An account of tests made with hypochlorite of lime. 1200 w. Eng Rec—Oct. 9, 1909. No. 8442.

The Purification of the Water Supply of Steelton, Pa. Discussion of the paper by James H. Fuertes. 2000 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8846 E.

Siphons.

Reinforced Concrete Siphons Across Sosa River and Canyon of Ribabona. B. A. Etcheverry. Illustrates and describes the method of construction. 3000 w. Cal Jour of Tech—Oct., 1909. No. 8760.

Softening.

Is Softened Water a Desirable Municipal Supply? Experience at McKeesport, Pa. A. G. Sandblad. Presented at Cent. States Water Convention. Considers the principal methods of water softening, and the effect of such water on the health of those using it. 2500 w. Eng News—Oct. 21, 1909. No. 8819.

Tanks.

The Klonne Type of High-level Storage Tank. A. Gradenwitz. Illustrated description, explaining the advantages. 600 w. Eng & Min Jour—Oct. 23, 1909. No. 8727.

WATERWAYS AND HARBORS.

Canals.

See United States, under RAILWAY ENGINEERING, MISCELLANY.

Docks.

A Large Coal Dock at Duluth. Illustrated description of dock and equipment for unloading from vessels and delivering to storage and cars the fuel supply of the D., M. & N. Ry. and the numerous large iron-ore mines operated along the line. 3500 w. Eng Rec—Oct. 23, 1909. No. 8701.

Dover.

The Admiralty Harbor at Dover. Illustrated description of the completed works and their construction. Plates. 5000 w. Engng—Oct. 15, 1909. No. 8896 A.

Dry Docks.

The Stability of Floating Docks. Bernard C. Laws. An illustrated article considering the equilibrium of single- and double-walled docks. 1500 w. Cassier's Mag—Oct., 1909. No. 8463 B.

An Off-Shore Floating Dock for Penarth. Illustrated description of a dock built at Cardiff. 400 w. Engr, Lond—Sept. 24, 1909. No. 8368 A.

Flood Protection.

Paxton Creek Flood Controlling Works, Harrisburg, Pennsylvania. R. M. Riegel. Illustrated detailed description of flood prevention works, and their construction. 3500 w. Cornell Civ Engr—Oct., 1909. No. 8839 C.

Floods.

The Monterey Flood and San Luisito Bridge. Samuel J. Lewis. An account of the flood of Aug. 27th last in the Santa Catarina River and the damage done, especially its effect on this reinforced-concrete bridge. Ills. 1800 w. Min & Sci Pr—Oct. 9, 1909. No. 8733.

Panama Canal.

Water Supply for the Lock Canal at Panama. Julio F. Sorzano. A discussion of whether the 40 ft. draft can be maintained at all times in the canal under the conditions which are possible and probable in the locality. 9800 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8845 E.

Piers.

Largest Pier on the Atlantic Coast. Illustrated description of the new pier at Boston, and its equipment. 4000 w. Marine Rev—Oct., 1909. No. 8551.

The Holland America Line Pier, Hoboken, N. J. The pier shed framework and fire wall and typical details of the structure are described and illustrated. 2500 w. Eng Rec—Oct. 16, 1909. No. 8595.

Shore Protection.

River Protection Work on the Kansas City Southern Railway, Near Braden, Okla. J. A. Lahmer. Describes the conditions, the temporary protection used, and the construction of the more durable protection by dikes. Ills. 2500 w. Pro Am Soc of Civ Engrs—Oct., 1909. No. 8844 E.

Turkey.

The Sea Ports of Turkey (Les Ports maritimes de la Turquie). Louis Godard. A review of the existing and projected harbors. Ills. 5300 w. Génie Civil—Sept. 4, 1909. No. 8628 D.

Vancouver.

See Victoria, B. C., under WATERWAYS AND HARBORS.

Victoria, B. C.

The Harbor of Victoria and Vancouver, British Columbia. H. Cole Estep. Illustrated description of the harbors and schemes for their improvement. 4000 w. Marine Rev—Oct., 1909. No. 8548.

Water Powers.

To Determine the Value of Water Power. W. T. Ryan. Explains simple methods of making an estimate of the available power. 1500 w. Power—Oct. 12, 1909. No. 8516.

MISCELLANY.

Architecture.

Influence on Architecture of Modern Construction. Henry H. Hill. Awarded Silver Medal of the Roy. Inst. of British Archts. An investigation of methods directly influencing architectural expression. 4500 w. Eng Rec—Oct. 23, 1909. No. 8708.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Radio-Telegraphy.

Recent Patents in Wireless Telegraphy and Telephony. W. H. Eccles. An illustrated review of the past year. 2000 w. Elect'n, Lond—Oct. 15, 1909. Serial. 1st part. No. 8869 A.

Recent Progress in Wireless Telegraphy and Telephony (Les Progres récente de la Télégraphie et de la Téléphonie sans Fil). H. Marchand. A review of recent inventions. Ills. 7500 w. Rev Gen des Sci—Sept. 15, 1909. No. 8610 D.

Wireless Telegraphy in the U. S. Navy. Information in regard to the equipments of the navy vessels. Ills. 1200 w. Elec Wld—Sept. 30, 1909. No. 8247.

Acoustics Tuning in Wireless Telegraphy. A brief description of the system of John H. Cuntz, in which electrical tuning is replaced by mechanical and acoustic syntonization. 800 w. Elec Engr, Lond—Oct. 8, 1909. No. 8858 A.

Radio-Telephony.

The Majorana System of Wireless Telephony. H. J. Reiff. Describes a new system of interest and practical value. Diagrams. 900 w. Elec Engr, Lond—Oct. 8, 1909. No. 8857 A.

Telegraph Batteries.

Characteristics of Dry Batteries. F. H. Loveridge. Indicates the classes of service they are best adapted to meet, and precautions that should be taken to insure best results. 3500 w. Elec Engr, Lond—Oct. 8, 1909. No. 8859 A.

Telegraph Cables.

Cable-Fault Localization Graphs in Practice. Edward Raymond-Barker. The first of a series of articles giving results of recent experience and research. 2500 w. Elec Rev, Lond—Oct. 8, 1909. Serial. 1st part. No. 8862 A.

Telegraph Lines.

See Telephone Lines, under COMMUNICATION.

Telegraph Printers.

The Murray Photo-Printing System. Describes a system designed to print in Roman type direct from line, using Wheatstone transmitting apparatus and the Morse alphabet. 2500 w. Elec Rev, Lond—Sept. 24, 1909. Serial. 1st part. No. 8341 A.

Telegraphy.

The C. R. Law and High-Speed Cable Telegraphy (Das C. R. Gesetz und die Kabelschnelltelegraphie). Bela Gati. Math-

We supply copies of these articles. See page 487.

ematical discussion, with large reference to A. E. Kennelly's formulæ. Ills. 3500 w. Elektrotech u Maschinenbau—Sept. 12, 1909. No. 8901 D.

See also Magnetic Storms, under ELECTRO-PHYSICS.

Tele-Mechanic.

Standard Clocks Operated by Wireless. Illustrates and describes a scheme of wireless operation of an extensive standard clock system in Vienna, Austria. 1000 w. Sci Am Sup—Oct. 23, 1909. No. 8588.

Telephone Lines.

Prominent Characteristics of Long Distance Telephone Lines. A. B. Domonoske. A brief discussion of the principal physical properties and phenomena of the telephone line. 1600 w. Cal Jour of Tech—Oct., 1909. No. 8759.

Telegraph and Telephone Systems as Affected by Alternating-Current Lines. J. B. Taylor. A statement of power transmission and telegraph and telephone conditions as they exist, with special reference to combinations, which may make trouble if operated simultaneously. Ills. 9500 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8534 F.

DISTRIBUTION.

Fuses.

Discussion on "Some Considerations in Designing Heavy Capacity Fuses." Discussion at Frontenac, N. Y., of paper by Louis W. Downes. 2200 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8540 F.

Industrial Plants.

Transmission and Maintenance of Electric Service for Industrial Plants. C. T. Maynard. Discusses water-power with steam auxiliary with special reference to mill and shop work. 2500 w. Elec Wld—Oct. 7, 1909. No. 8397.

Switches.

Recent Low-Tension Apparatus (Neuerungen im Apparatebau für niederspannung). Describes the apparatus manufactured by the Paul Meyer Company, Berlin. The first parts deal with switches and circuit breakers. Ills. Serial. 1st part. 1000 w. Elektrotechniker—Sept. 10, 1909. No. 8699 D.

Wiring.

Wiring of High-Grade Apartment House. N. M. Schoonmaker. Illustrated description. 1200 w. Elec Wld—Sept. 30, 1909. No. 8252.

DYNAMOS AND MOTORS.

A. C. Dynamos.

Voltage Wave-Form of Delta-Connected Alternator. Shiro Sano. A mathematical study. 400 w. Elec Wld—Oct. 14, 1909. No. 8555.

The Rational Selection of Alternating-Current Generators. F. D. Newbury. Calls attention to the important characteristics of the alternator, and discusses factors determining the selection for a required service. 5000 w. Elec Jour—Oct., 1909. No. 8525.

Effects of a Third Harmonic in the E. M. F. Wave of a Three-Phase Generator. F. M. Denton. Also editorial. Considers the subject from an oscillographic point of view, and contains a plea for star-wound armatures as contrasted with delta-wound. 2500 w. Elec Wld—Oct. 14, 1909. No. 8556.

A. C. Motors.

The Calculation of Single-Phase Commutator Motors. J. Fischer-Hinnen. Abstract from *Elektrotechnische Zeitschrift*. Treats the subject from a practical standpoint and is devoted to the calculation and design of these machines. 2500 w. Elect'n, Lond—Sept. 24, 1909. No. 8345 A.

Discussion on "Reduction in Capacity of Polyphase Motors Due to Unbalancing in Voltage." The paper by S. B. Charters, Jr., and W. A. Hillebrand is discussed at Frontenac, N. Y. 3000 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8543 F.

The Rotating-Field Theory of the Single-Phase Commutator Motor (Drehfeldtheorie der Einphasenkollektormotoren). Friedrich Schmidt. Mathematical. Ills. 4000 w. Elektrotech u Maschinenbau—Sept. 26, 1909. No. 8903 D.

Armatures.

The Tips of Teeth on Armature Cores. Miles Walker. Deals with the main considerations controlling the design of tips of teeth and the effect of the shape on the magnetic leakage. 1200 w. Elect'n, Lond—Oct. 1, 1909. No. 8484 A.

Braking.

Dynamic Braking. C. E. Daniells. An explanation of the generator action that causes the braking effect, and the advantages and applications of dynamic braking. 1200 w. Elec Wld—Oct. 7, 1909. No. 8399.

Dampeners.

Some Casual Remarks on Dampeners. Warren H. Miller. Illustrates types, discussing their merits and defects. 2500 w. Elec Wld—Sept. 30, 1909. No. 8250.

Induction Motors.

Speed Control of Induction Motors by Frequency Changers. H. C. Specht. Describes methods, explaining principles upon which they are based. 2500 w. Elec Jour—Oct., 1909. No. 8527.

Discussion on "Multispeed Induction Motors." Discussion at Frontenac, N. Y., of paper by H. G. Reist and H. Maxwell. 2000 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8536 F.

Discussion on "The Heating of Induction Motors." Discussion at Frontenac, N. Y., of the paper of A. Miller Gray. 900 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8537 F.

A Graphical Treatment of the Induction Coupling (Die graphische Behandlung der Induktionskupplung). Hermann Zipp. An

exhaustive theoretical discussion. Ills. Serial. 1st part. 3000 w. Elek Kraft u Bahnen—Sept. 14, 1909. No. 8906 D.

Interpoles.

Interpole Generators and Motors. W. B. Hird. Explains the principle of interpole designs and the advantages of their use. 2000 w. Elec Engr, Lond—Oct. 1, 1909. No. 8480 A.

The Interpole for Railway Motors. W. B. Kouwenhoven. Explains the action of the interpole in preventing sparking and prolonging the life of the commutator and brushes. Diagrams. 2000 w. Ry & Loc Engng—Oct., 1909. No. 8301 C.

Experimental Method of Adjusting Interpole Windings. Howard M. Nichols. Suggestions for the designing and adjustment of interpoles. 600 w. Elec Wld—Oct. 7, 1909. No. 8398.

Railway Motors.

See Interpoles, under DYNAMOS AND MOTORS.

Resistances.

Determination of Resistances by Graphics. F. W. Harris. Explains the development of the graphical method of designing resistances for motor control. 2000 w. Elec Jour—Oct., 1909. No. 8528.

Starters.

Interlocked Motor Starters and Shunt Regulators. T. Golding and O. C. Dinerman. Illustrates and describes some of the methods adopted. 1500 w. Elec Rev, Lond—Oct. 15, 1909. No. 8866 A.

Current Load in the Individual Resistors in an Automatic Starter (Ueber die Strombelastung der einzelnen Widerstandsstufen der Selbstanlasser). Robert Edler. Mathematical. Ills. Serial. 1st part. 4000 w. Elektrotech u Maschinenbau—Sept. 5, 1909. No. 8900 D.

ELECTRO-CHEMISTRY.

Calcium Carbide.

Calcium Carbide. C. A. Hansen. A paper before the Int. Cong. of Ap. Chem. A report of research work. Ills. 1200 w. Elec-Chem & Met Ind—Oct., 1909. No. 8328 C.

Corrosion.

The Corrosion of Iron. J. Newton Friend. Read before the Ir. & St. Inst. Discusses the various theories and considers the balance of evidence in favor of the acid theory. Refers to conclusions of Dr. William H. Walker. 1500 w. Engng—Oct. 15, 1909. No. 8936 A.

See also Pipe Corrosion, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Electric Furnaces.

The Laws of Electrode Losses in Electric Furnaces. Carl Hering. Gives the laws deduced by the writer, explaining the assumptions on which they are based, and giving proofs and examples. 7500 w. Elec-Chem & Met Ind—Oct., 1909. No. 8332 C.

Electrolysis.

Electrolysis with Magnesium Kathodes (Ueber Elektrolyse mit Magnesiumkathoden). Dr. Fr. Schmidt. A report of experimental research. Ills. Serial. 1st part. 2000 w. Elektrochem Zeitschr—Sept., 1909. No. 8646 D.

Electrolytic Assaying.

The Laboratory for Electro-Analysis at Purdue University. Edward G. Mahin. Illustrated detailed description of a rather unique installation. 1200 w. Elec-Chem & Met Ind—Oct., 1909. No. 8331 C.

Electro-Metallurgy.

See Zinc Smelting, under MINING AND METALLURGY, LEAD AND ZINC.

Electroplating.

Coppering Iron or Steel Articles before Nickeling. Shows that a study of each case is necessary to prevent "spotting out," and other troubles. 1600 w. Brass Wld—Oct., 1909. No. 8838.

Nitrogen.

The Utilization of Atmospheric Nitrogen. A. Bernthsen. Discusses methods of fixing atmospheric nitrogen, and the utility of the product. 5000 w. Eng & Min Jour—Oct. 16, 1909. No. 8721.

The Innsbruck Plant for Nitric Acid from Air. Brief illustrated description of a process for the fixation of atmospheric nitrogen working in the Tyrol. The inventors are H. & G. Pauling. 1000 w. Elec-Chem & Met Ind—Oct., 1909. No. 8329 C.

Valve Electrodes.

The Metal Tungsten as "Valve" Electrode. L. H. Walter. Shows that the metal tungsten behaves as a valve electrode in a large number of electrolytes. 1500 w. Elect'n, Lond—Oct. 1, 1909. No. 8486 A.

ELECTRO-PHYSICS.

Electromagnets.

Test of Electromagnets. C. P. Nachod. Brief account of tests made to determine the most suitable form of magnets of given dimensions. Ills. 400 w. Elec Wld—Sept. 30, 1909. No. 8248.

Flames.

Effect of a Magnetic Field on the Electrical Conductivity of Flame. Prof. H. A. Wilson. An account of some measurements of the change in the conductivity of a Bunsen flame produced by a magnetic field. 900 w. Elect'n, Lond—Sept. 24, 1909. No. 8347 A.

Magnetic Storms.

The Magnetic Storm of September 25th. An account of the storm and the interruption it caused to telegraphic communication. 2200 w. Elect'n, Lond—Oct. 8, 1909. No. 8868 A.

Radioactivity.

Radium Emanation. F. H. Mason. Remarks on the experiments carried out jointly by Sir William Ramsey and Robert Whytlaw Gray to determine the

atomic weight of "radium emanation." 1200 w. Min & Sci Pr—Sept. 25, 1909. No. 8227.

GENERATING STATIONS

Central Stations.

Sixteen Months Record at Redondo. Gives operating results at this reciprocating-engine station in California. 1200 w. Power—Oct. 19, 1909. No. 8771.

The Berlin System of Central Stations. Frank Koester. An illustrated account of the growth of the "Berliner Electricitäts Werke" and the operation of the system of central stations and distribution. 3500 w. Engineering Magazine—Nov., 1909. No. 8835 B.

The New Firenze Central Station of the Italian State Railways (La nuova Centrale elettrica nelle Officine delle Ferrovie dello Stato a Firenze e le relative Esperienze di Rendimento). Illustrated description of this gas power station. Serial. 1st part. 2500 w. Ing Ferro—Sept. 16, 1909. No. 8643 D.

See also Steam Heating, under MECHANICAL ENGINEERING, HEATING AND COOLING.

Design.

Simplicity in Design. Alington Johnston. Shows the necessity of adopting the simplest methods of arrangement of steam and electrical machinery in a generating station to facilitate easy operation. 1200 w. Elec Rev, Lond—Oct. 8, 1909. No. 8864 A.

Economics.

Central Station Electric Motor Service. Walter Stuart Kelley. Considers the underlying principles that should govern the design for an electrical energy distribution system, from the viewpoint of the central station. 3000 w. Elec Wld—Oct. 7, 1909. No. 8395.

Great Britain.

Central-Station Commercial Development in Great Britain. Francis H. Davies. A brief review of progress. 1800 w. Elec Wld—Oct. 14, 1909. No. 8557.

Hydro-Electric.

The Municipal Hydro-Electric Works for Winnipeg. Brief account of the undertaking, with plan and cross section through power-house. 1000 w. Eng Rec—Oct. 9, 1909. No. 8439.

Low-Head Hydro-electric Development on Tippecanoe River at Monticello, Ind. Illustrated detailed description of an interesting moderate-sized water-power development. 1800 w. Elec Wld—Oct. 21, 1909. No. 8808.

The Brusio Central Station. J. B. Van Brussel. Illustrated description of an important hydro-electric installation in Switzerland. 2500 w. Power—Oct. 5, 1909. No. 8317.

The Altback Hydro-Electric Plant (Elektrizitätswerk Altbach). Wilhelm Müller. Illustrated description. 2500 w. Die Turbine—Sept. 20, 1909. No. 8676 D.

The Orlu Hydro-Electric Plant, Ariège, France (L'Usine hydroélectrique d'Orlu, Ariège). E. Pacoret. Illustrated detailed description of this important station in the Pyrenees. Serial. 1st part. 2000 w. Tech Mod—Sept., 1909. No. 8616 D.

Power Developments on the Glommen (Stand der Wasserkraftausnutzung am Glommen). Herr Dubislav. Describes the electric plants on this river in Norway. Ills. Serial. 1st part. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 10, 1909. No. 8677 D.

Isolated Plants.

Gas Engine Driven Electric Plants Versus Electric Motors Fed from Central Stations. R. D. Donaldson. A comparison of costs, reliability and general running conditions of small gas engines generating electricity for manufacturing versus the purchase from a central station. 1200 w. Elec Wld—Oct. 7, 1909. No. 8396.

Power House of the Rock Island R. R. Shops. Osborn Monnett. Illustrated description of an alternating-current turbine plant that is featured by water supply, simple coal and ash handling facilities and electrical distribution. 3500 w. Power—Oct. 19, 1909. No. 8768.

Power Plant of the Coronet Phosphate Company. H. D. Mendenhall. A steam-turbine driven electrical generating plant in Florida is illustrated and described. 4500 w. Eng Rec—Oct. 23, 1909. No. 8707.

Rates.

An English Central-Station Rate System. A. Hugh Seabrook. Gives the writer's recommendations for a revised tariff for the Borough of St. Marylebone. 3000 w. Elec Wld—Oct. 14, 1909. No. 8558.

LIGHTING.

Arc Lamps.

Flame Arc-Lamp Carbons. K. Odwald. Their composition, structure, special details of lamp construction, etc. Ills. 1800 w. Elec Rev, N Y—Oct. 9, 1909. No. 8423.

Illumination.

The Hudson-Fulton Celebration in New York City. Illustrates and describes some of the illuminating effects. 3000 w. Elec Wld—Sept. 30, 1909. No. 8249.

See also Shop Lighting, under MACHINE WORKS AND FOUNDRIES.

Incandescent Lamps.

The Conservation of Our Natural Resources Through the Use of High Efficiency Lamps. S. E. Doane. Considers the great saving in fuel possible by a liberal replacement of carbon lamps by high-efficiency lamps. Also discusses rates. 5000 w. Cent Sta—Oct., 1909. No. 8451.

We supply copies of these articles. See page 487.

Some Modern Metal Filament Lamps and Fittings. Illustrated review of recent progress. 2500 w. Elect'n, Lond—Oct. 15, 1909. No. 8870 A.

Metallic Filament Lamps. W. H. Alabaster. Read before the Elec. Assn. of Victoria. Discusses their effect upon interior illumination. Also discussion. 8500 w. Aust Min Stand—Sept. 1, 8, and 22, 1909. Serial. 3 parts. No. 8826 each B.

The Installation of Tungsten Lamps for Factory Illumination. Arthur Gillman. Describes methods for damping filament-destroying vibrations, and other points relating to the installation of tungsten lamps. Ills. 2000 w. Elec Wld—Oct. 7, 1909. No. 8401.

Industrial Plant Illumination with Tungstens. Arthur Gillman. Illustrates and describes some methods whereby the difficulties inherent to tungsten lamps installed under factory conditions may be overcome. 1000 w. Elec Wld—Sept. 30, 1909. No. 8251.

Illumination of Shop Yards by Means of Tungsten Lamps. Arthur Gillman. Describes details of such installations. Ills. 700 w. Elec Wld—Oct. 14, 1909. No. 8559.

Investigations on 220-Volt Metallic-Filament Lamps (Versuche mit 220 voltigen Metallfadenlampen). Hr. Einberger. Gives results of tests in a series of curves. Ills. 2500 w. Zeitschr d Ver Deutscher Ing—Sept. 25, 1909. No. 8918 D.

Street.

New Methods and Specifications for Street Lighting. J. H. Perkins. Abstract of paper read before the Penn. Elec. Assn. Discusses the present and possible future trend in street illumination. 3500 w. Elec Rev, N Y—Oct. 2, 1909. No. 8309.

Street-Lighting Earnings in Massachusetts Cities. Gives street lighting comparisons for the year ending June 30, 1908, from returns submitted by a number of urban companies. 1200 w. Elec Wld—Oct. 21, 1909. No. 8811.

Street Lighting in Budapest. Francis Jehl. A brief account of an arc lamp trial circuit installed, which has been said to be one of the most perfect systems of street lighting yet invented. 1200 w. Elec Wld—Oct. 21, 1909. No. 8810.

Multiple Tungsten Street Lighting for Grinnell, Iowa. Describes the system adopted. 2000 w. Elec Wld—Oct. 14, 1909. No. 8560.

MEASUREMENT.

Eddy-Current Loss.

See Hysteresis, under MEASUREMENT.

Hysteresis.

Magnetic Testing of Iron with Alternating Current. Albert Campbell. Describes the method by which tests for hysteresis and eddy current loss are carried out at the Nat. Phys. Laboratory, and gives some of the results. 3000 w. Elec Engr, Lond—Sept. 24, 1909. No. 8339 A.

Instruments.

Ammeter for the Accurate Measurement of Large Alternating Currents. E. F. Northrup. Discusses the laws governing the pressure in a conductor of circular cross-section conveying on electric current, and describes an ammeter based on the variation of the pressure in a liquid conductor. 3500 w. Elect'n, Lond—Oct. 1, 1909. No. 8488 A.

Wheatstone Bridge.

A Source of Error in Measurements with the Alternating-Current Bridge (Ueber eine Fehlerquelle bei Messungen mit der Wechselstrombrücke). Herr Behne. Mathematical discussion of the effect of the possible capacity of the bridge arms against earth. Ills. 3000 w. Elektrotech u Maschinenbau—Sept. 19, 1909. No. 8902 D.

TRANSMISSION.

Cables.

Discussion on "Surges on Cable Systems with Aluminum Cell Protection." The paper by E. E. F. Creighton and S. D. Strong is discussed at Frontenac, N. Y. Ills. 3000 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8539 F.

Condensers.

Protection Against High-Pressure Discharges. Illustrated description of the Morscicki condenser and its use, combined with the Giles electric valve, for the protection of cables. 1800 w. Elec Rev, Lond—Oct. 1, 1909. No. 8481 A.

Conduits.

Electric Conduit System at Baltimore. Notes from the last report of Charles E. Phelps, Jr., giving the history of this undertaking. 1700 w. Eng Rec—Oct. 9, 1909. No. 8446.

High Tension.

Problems of High-Tension Power Transmission. J. G. Pertsch. Brief review of the development of high-voltage transmission, and discussion of the factors tending to a limitation. 1500 w. Sibley Jour of Engng—Oct., 1909. No. 8758 C.

Lightning Protection.

Damage by Lightning. Discusses conductor systems and the ignorance of some who are permitted to install them. 3000 w. Elec Rev, Lond—Oct. 1, 1909. No. 8482 A.

Lightning Protection. J. V. E. Titus. Abstract of paper before the Am. St. & Int. Ry. Engng Assn. Considers the installation of arresters, their design, and the service results. 2500 w. Elec Ry Jour—Oct. 8, 1909. No. 8511.

Line Construction.

The Construction of High-Tension Transmission Lines (Der mechanische Bau von Hochspannungs-Fernleitungen). Herbert Kyser. Discusses the mechanical

details of construction, properties of materials, etc. Ills. 3200 w. Elek Kraft u Bahnen—Sept. 14, 1909. No. 8907 D.

Lines.

Notes on Long Distance Transmissions. E. Kilburn Scott. Notes on the development in power transmission work, construction, etc. 2000 w. Elec Engr, Lond—Sept. 24, 1909. No. 8340 A.

Some Notes on California High-Tension Transmission Lines. S. L. Foster. Abstract of paper before Am. St. & Int. Ry. Engng. Assn. Describes briefly the conditions and the construction of high-tension lines in California, the insulators used, and precautions necessary in repair work. 2500 w. Elec Ry Jour—Oct. 8, 1909. No. 8512.

Poles.

Some Notes on the Erection of Poles for Overhead Lines. Suggestions helpful to those engaged in this work. 1500 w. Elec Rev, Lond—Oct. 1, 1909. No. 8483 A.

Protective Devices.

Protection of Electrical Equipment. P. M. Lincoln. Read at Seattle convention of N.-W. Elec. Lgt. & Power Assn. Discusses the protection of electrical apparatus and transmission lines from the danger of breakdown to which such apparatus is subjected by electrical "surges." 3500 w. Elec Engr, Lond—Oct. 15, 1909. No. 8861 A.

Regulations.

Legislation on the Transmission of Electrical Energy (Législation sur les Distributions d'Énergie électrique). Armand Halleux. Considers the relation of the regulations existing in other countries to conditions in Belgium. 3500 w. Soc Belge d'Elecns—Sept., 1909. No. 8601 E.

Resonance.

The Phenomena of Resonance in Electric Lines. J. Dalemont. Discusses the cause, and accidents due to resonance, and how to avoid them. 1500 w. Can Engr—Oct. 1, 1909. No. 8306.

Transformers.

The Electrical Transformer. Norman G. Meade. An illustrated practical explanation of the essential features and different types, what they are used for, how cooled, etc. 1500 w. Power—Oct. 5, 1909. No. 8319.

Discussion on "Corona Phenomena in Air and Oil and Their Relation to Transformer Design." The paper of W. S. Moody and G. Faccioli, as discussed at Frontenac, N. Y. 2500 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8538 F.

Discussion on "Testing of Transformer Steel." The paper by M. G. Lloyd and J. V. S. Fisher is discussed at Frontenac, N. Y. 2500 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8535 F.

Discussion on "Electrical Measurements on Circuits Requiring Current and Potential Transformers" Discussion at Frontenac, N. Y., of L. T. Robinson's paper. 3500 w. Pro Am Inst of Elec Engrs—Oct., 1909. No. 8541 F.

MISCELLANY.

Electric Clocks.

Electric Time Service in Eastern Observatories. Illustrated description of the two new master clocks installed at the observatory in Mauritius, and their operation. 1500 w. Elec Rev, Lond—Oct. 15, 1909. No. 8865 A.

Nickel Alloys.

Resistivity and Thermo-Electric Properties of Nickel and Its Common Alloys and Their Industrial Applications (Résistivité et Thermo-Electricité des nickels et de leurs Alliages Usuels, Applications Industrielles). H. Pécheux. A review of their application in the electrical industries. Ills. 5600 w. Rev Gen des Sci—Sept. 30, 1909. No. 8611 D.

INDUSTRIAL ECONOMY.

Alaska.

Alaska. A. J. Quigley. An illustrated account of the wealth of its natural resources, and its commercial possibilities. 6000 w. Cassier's Mag—Oct., 1909. No. 8464 B.

Cost Systems.

The Distribution of Foundry Tonnage Burden. F. L. Pinkham. A commentary on Mr. Victor R. Claydon's cost problem, with rejoinder. 700 w. Engineering Magazine—Nov., 1909. No. 8836 B.

Education.

The Relations Between Applied Chemistry and Engineering. John B. C. Kershaw. Discusses present tendency to combine these two branches and the necessity of training engineers in chemistry. 2700 w. Indus Engng—Oct. 15, 1909. No. 8579 B.

Electrical Inventions and the Training of the Electrical Engineer. J. A. Fleming. Discourse delivered at University College, London. Suggestions and advice of interest to engineering students. 5000 w. Elec Engr, Lond—Oct. 8, 1909. No. 8856 A.

The Education of Youth and the Royal Naval Academy (L'Educazione della Gioventù e la R Accademia Navale). T. Rosati. A discussion of the conditions of naval engineering education in Italy. 13000

We supply copies of these articles. See page 487.

w. Riv Marit—Sept., 1909. No. 8634 E + F.

Industrial Education. Read before the Nat. Machine Tool Bldrs.' Assn. The Cincinnati plan is discussed by Frederick A. Geier; and the Fitchburg plan, by M. A. Coolidge. 2500 w. Ir Age—Oct. 14, 1909. No. 8547.

Training for Saving in Manufacturing. E. L. Shuey. Discusses preparation for their work of superintendents and engineers. 2200 w. Indus Engng—Oct. 15, 1909. No. 8577 B.

Discussion on "The Training of Non-Technical Men" and "The Value of Classics in Engineering Education." The papers by C. R. Dooley and by Charles P. Steinmetz, as discussed at Frontenac, N. Y. 10800 w. Pro Am Inst of Elec Engrs —Oct., 1909. No. 8542 F.

Engineering Profession.

The Status of the Engineering Profession. G. Allan Thomas. Prize paper. Outlines a scheme by which the engineering profession might be maintained on an equality with other professions. 4500 w. Soc of Engrs—Oct. 4, 1909. No. 8764 N.

Industrial Betterment.

See Welfare Work, under MINING AND METALLURGY, MINING.

Industrial Legislation.

The Home Office and Ship-platers Wage Rates. Editorial on some of the disadvantages of hasty and ill-considered legislation when applied to commerce and industry. 1500 w. Engng—Sept. 24, 1909. No. 8366 A.

Industrial Museums.

A Visit to the German Museum in Munich (Ein Besuch im Deutschen Museum in München). Conrad Matschoss. Brief notes on a large number of exhibits. Ills. Serial. 1st part. 3600 w. Zeitschr d Ver Deutscher Ing—Sept. 18, 1909. No. 8915 D.

Labor Insurance.

A Project for a National System of Labor Insurance (Bemerkungen zum Entwurf einer Reichsversicherungsordnung). Otto Graf. Discussion of conditions and prospects of labor insurance in Germany. Ills. 5000 w. Tech u Wirt—Sept., 1909. No. 8912 D.

Labor Unions.

The Trade Union Movement. John Mitchell. Speech to the students of the Yale Divinity School. A discussion of the industrial problem and the work of organized labor unions. 4500 w. Yale Sci M—Oct., 1909. No. 8765 C.

Management.

Organization by Production Factors. A. Hamilton Church. This second article of a series discusses production factors as related to cost accounts and staff. 4500 w. Engineering Magazine—Nov., 1909. No. 8831 B.

Engineering Training and Workshop Organization. Joseph H. Stubbs. Presidential address before the Manchester Assn. of Engrs. A discussion of engineering efficiency and methods and systems by which it may be obtained. 3000 w. Mech Engr—Oct. 15, 1909. Serial. 1st part. No. 8883 A.

A Test of the Application of the Taylor System in a Large French Works (Quelques Notes sur un Essai d'Application du Système Taylor dans un Grand Atelier de Mécanique Français). Georges de Ram. Brief note on the general results. 2000 w. Rev de Métal—Sept., 1909. No. 8604 E + F.

Natural Resources.

See Incandescent Lamps, under ELECTRICAL ENGINEERING, LIGHTING.

Patents.

See Western Railroad Association, under RAILWAY ENGINEERING, MISCELLANY.

Standardization.

Standardization in Engineering. Henry Adams. Presidential address before the Assn. of Engineers-in-Charge. 5000 w. Elec Engr, Lond—Oct. 15, 1909. No. 8860 A.

Tariff.

The Tariff Law of 1909. H. Parker Willis. A study of its effect on the side of administration and international relationships. 6000 w. Jour of Acc—Sept., 1909. No. 8503 C.

MARINE AND NAVAL ENGINEERING.

Battleships.

The French Battleships Diderot and Condorcet. Illustrates and describes ships of the Danton class. 2000 w. Int Marine Engng—Oct., 1909. No. 8322 C.

The Visiting Warships—A Comparison. A criticism of the naval parade of the Hudson-Fulton celebration, with illustrations and a comparison of the warships assembled. 2000 w. Sci Am—Oct. 9, 1909. No. 8413.

Compasses.

Improvements in Ship's Compasses. Explains disturbances of the compass due to the use of so much iron in ships and other causes, and the efforts made to solve the problem. Also recording apparatus for showing the course of the ship. 2000 w. Sci Am Sup—Oct. 2, 1909. No. 8213.

Dredges.

Handling Dredged Material by Suction

We supply copies of these articles. See page 487.

and by Pressure (Déchargeuses à Succion et à Refoulement pour les Déblais de Dragages). F. Hofer. Describes three types of dredges in use in harbors in Europe. Ills. 2000 w. Génie Civil—Sept. 4, 1909. No. 8627 D.

The 10,000-Ton Suction Dredger "Leviathan" for Use on the Mersey. Illustrated description of the most powerful dredges yet placed in operation. 1700 w. Sci Am—Nov. 6, 1909. No. 9079.

Ferry Steamers.

Train-Ferry Steamer "Fabius" for Northern Niagara. Illustrated description of a 3-ft. 6-in. gauge railway train-ferry steamer. 1400 w. Engng—Oct. 1, 1909. No. 8490 A.

French Navy.

The Report of the Commission of Inquiry on the French Navy (Il Rapporto della Commissione d'Inchiesta sulla Marina francese). Luigi Barberis. A discussion of the report from the Italian point of view 10000 w. Riv Marit—Sept., 1909. No. 8635 E + F.

Gas Engines.

Dutch Marine Suction-Gas Plants. F. Muller Van Brakel. Illustrated description of an engine that can be managed by non-technical men; its construction is dealt with in the present article. 2000 w. Int Marine Engng—Oct., 1909. Serial. 1st part. No. 8325 C.

Gasoline Engines.

Four-Stroke Marine Engines and Their Cylinders. A. H. Ziegler. Discusses the design of marine gasoline engines. 4500 w. Rudder—Oct., 1909. Serial. 1st part. No. 8457 C.

Oil Fuel.

See Steamships, under MARINE AND NAVAL ENGINEERING.

Porhydrometer.

The Porhydrometer. An account of tests made of this instrument for weighing the cargo of ships. Ills. 1000 w. Marine Rev—Oct., 1909. No. 8550.

Refrigeration.

Sea Transport of Bananas Under Refrigeration. H. J. Ward. Illustrated description of steamers used in banana trade between West Indies and Great Britain and methods of loading. 2000 w. Cold Stor & Ice—Oct., 1909. No. 8572 C.

Shipbuilding.

German Shipyards. The first of a series of articles illustrating and describing the large private shipyards of Germany. 1200 w. Engr, Lond—Oct. 8, 1909. Serial. 1st part. No. 8942 A.

Ship Design.

Relation of Size to Speed in Ships. Sidney G. Koon. Gives calculations made in connection with the design of a vessel for special requirements. 1000 w. Sci Am—Nov. 6, 1909. No. 9078.

Ship Resistance.

A Note on the Determination of Ship Resistance (Etwas über die Bestimmung des Schiffswiderstandes). J. K. E. Triebart. Mathematical discussion. Ills. Serial. 1st part. 5500 w. Schiffbau—Sept. 8, 1909. No. 8669 D.

Steamboats.

A Brief History of Early Steam Navigation in the United States. Reviews the work of Fulton, Stevens, and Fitch. Ills. 1800 w. Jour Am Soc of Mech Engrs—Oct., 1909. No. 8529 F.

The Early History of Steam Navigation. An illustrated account taken from a work by Robertson Buchanan, published in 1816, describing early vessels propelled by steam, and by machinery driven by cattle. 2500 w. Engr, Lond—Oct. 8, 1909. No. 8941 A.

Steam Engines.

Engines of the Steamship Graceful. Plate and illustrated description of engines for a quarter-deck type steel vessel designed for the coasting trade. The feature of particular interest is the condenser. 800 w. Engr, Lond—Oct. 1, 1909. No. 8497 A.

Steamships.

British Tank Steamers for the Pacific Trade. Describes vessels fitted to run under oil fuel, reporting trial. Ills. 600 w. Engr, Lond—Oct. 15, 1909. No. 8947 A.

The Orient Company's Twin-Screw Liners "Otranto" and "Orvieto." Illustrated detailed description of these Australian mail liners, recently completed. 3500 w. Engng—Oct. 29, 1909. No. 9183 A.

The Twin-Screw Steamer "George Washington" (Der Doppelschraubendampfer "George Washington"). Ernst Kurtzahn. Illustrated description, with plates. 3000 w. Zeitschr d Ver Deutscher Ing—Sept. 25, 1909. No. 8917 D.

The Latest Twin-Screw Passenger and Freight Steamer "George Washington" of the North German Lloyd (Der neueste Doppelschrauben-Passagier- und Frachtendampfer "George Washington" des Norddeutschen Lloyd, Bremen). A. Schromm. Illustrated description. Plates. Serial. 1st part. 4500 w. Oest Wochenschr f d Oeffent Baudienst—Sept. 18, 1909. No. 8693 D.

Submarines.

The Latest Submarines of the United States Navy. Illustrated detailed description of the "Narwahl." Also an article on "An All-Seeing Eye for the Submarine." 2500 w. Sci Am—Oct. 23, 1909. No. 8585.

Torpedoes.

The Torpedo—A Machine Shop Triumph. Samuel Aronson. History of its development and illustrated description of the Bliss-Leavitt torpedo. 4000 w. Am Mach—Vol. 32. No. 41. No. 8798.

We supply copies of these articles. See page 487.

MECHANICAL ENGINEERING.

AUTOMOBILES.

Babcock.

Silent Running Babcock Electric. Illustrated detailed description. 1400 w. Automobile—Oct. 7, 1909. No. 8421.

Brass Founding.

The "Bohl" Process of Casting Brass and Other Metals in Plaster of Paris Molds. E. L. H. Bohl. Describes the process and illustrates work accomplished. 2200 w. Brass Wld—Oct., 1909. No. 8837.

Brush.

Brush Line Expanded for 1910. Discusses the mechanical features of the Brush cars. Ills. 2500 w. Automobile—Oct. 14, 1909. No. 8786.

Cabs.

Motor Cabs in London (Ergänzendes über die Londoner Motordroschken). Herbert Bauer. Reviews progress since the end of 1907. Ills. 3200 w. Zeitschr d Mit Motorwagen Ver—Sept. 30, 1909. No. 8671 D.

Cadillac.

Quantity Production and Quality in Car Construction. Illustrated description of a low-priced 20-30 h. p. Cadillac car. 1200 w. Auto Jour—Oct. 16, 1909. Serial. 1st part. No. 8852 A.

Carburettors.

Distinctive Carburettor Development. Illustrated description of the latest Gillett-Lehmann model. 3500 w. Auto Jour—Oct. 9, 1909. No. 8850 A.

Improving Carbureter Flexibility. H. L. Towle. Considers some spring characteristics and how to improve running at low speeds. 2200 w. Automobile—Oct. 7, 1909. No. 8419.

Clutches.

See same title, under MACHINE ELEMENTS AND DESIGN.

Commercial Vehicles.

Grabowsky's 3 Ton Power Wagon. Illustrated detailed description. 2000 w. Automobile—Oct. 21, 1909. No. 8791.

See also Tractors, under AUTOMOBILES.

Construction.

See Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Design.

Motor Body Building. Discusses the difference between a good and bad body. Ills. 4400 w. Autocar—Oct. 2, 1909. No. 8470 A.

Recent Progress in Automobile Design (Neuere Automobilkonstruktionen). Fritz Meitner. The first instalment describes the new Adler four-cylinder motor. Ills. Serial. 1st part. 800 w. Motorwagen—Sept. 10, 1909. No. 8674 D.

See also Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Fire Apparatus.

Motor Fire Apparatus in Hamburg (Feuerwehr-Automobile in Hamburg). Describes a number of recent vehicles. Ills. 3100 w. Zeitschr d Mit Motorwagen Ver—Sept. 30, 1909. No. 8672 D.

Garages.

Some Solutions of the Private Garage Problem. Morris A. Hall. Suggestions in regard to buildings, tools needed, and related matters. Ills. 2800 w. Automobile—Oct. 21, 1909. Serial. 1st part. No. 8789.

Gears.

Treatment of Gears for Automobile Motors and Transmissions. Harold Whiting Slauson. Illustrates and describes the practice at a number of factories. 2000 w. Mach, N Y—Oct., 1909. No. 8287 C.

Hupmobile.

Hupmobile from a New Home. Illustrates and describes Model B, the design for 1910. 1500 w. Automobile—Oct. 21, 1909. No. 8790.

Ignition.

Misfiring: Some Causes and Some Remedies. Stillman Taylor. Discusses causes that contribute to misfiring and the remedies. 2500 w. Automobile—Oct. 14, 1909. No. 8784.

Jackson.

Jackson Projects for 1910. Illustrates and describes the new models of this company. 1800 w. Automobile—Oct. 14, 1909. No. 8787.

Maudslay.

A Coventry-Built Seventeen. Illustrated detailed description of the 17 h. p. Maudslay car. 1700 w. Auto Jour—Oct. 9, 1909. No. 8851 A.

Motors.

Direct Fuel Injection Two-Cycle Motors. Thomas J. Fay. Discusses the advantages of directly injected fuel, the results, etc. Ills. 1500 w. Automobile—Oct. 14, 1909. No. 8785.

Phenomena of Combustion in the Engine Cylinder. Explains the function of the explosive mixture, treating the subject qualitatively rather than quantitatively. 3000 w. Autocar—Sept. 25, 1909. No. 8334 A.

Omnibuses.

Economy and Operating Costs of Electric Motor Buses (Wirtschaftlichkeit und Betriebskosten elektrischer Autobusse). B. v. Lengerke. Results of tests in Berlin. Ills. Serial. 1st part. 1500 w. Motorwagen—Sept. 10, 1909. No. 8673 D.

Panhard.

The 12-15 h. p. Panhard Car. Illustrated description of a new car. 1200 w. Autocar—Oct. 2, 1909. No. 8469 A.

We supply copies of these articles. See page 487.

Pumps.

See Radiators, under AUTOMOBILES.

Radiators.

Up-to-Date Accessory Features of Radiators and Pumps. Thomas J. Fay. Describes the radiators of the McCord Mfg. Co. Ills. 2000 w. Automobile—Oct. 21, 1909. Serial. 1st part. No. 8788.

Rambler.

New Rambler Models for 1910. An illustrated description of new cars, calling attention to new features. 2000 w. Automobile—Oct. 7, 1909. No. 8420.

Standardization.

Standard Automobile Parts Adopted by the A. L. A. M. With data supplement. Special specifications for a standard spark plug, and for adjustable and solid yoke and eye rod ends, and a h. p. formula. 400 w. Mach, N Y—Oct., 1909. No. 8286 C.

Steering Gear.

Some Observations on the Steering Gear. Thomas J. Fay. Discusses points of design and construction. 1600 w. Automobile—Sept. 30, 1909. No. 8228.

Straker-Squire.

A Striking British Fourteen. Illustrated detailed description of the Straker-Squire touring car. 800 w. Auto Jour—Sept. 25, 1909. No. 8335 A.

Sunbeam.

The New 12-16 h. p. Sunbeam. Illustrated description of a live-axle car with 80 x 120 m. m. four-cylinder engine and four speeds. 1500 w. Autocar—Oct. 16, 1909. No. 8855 A.

Talbot.

The 35 h. p. Four-Cylinder Talbot. Illustrates and describes particulars of the largest Talbot model. 1200 w. Autocar—Oct. 16, 1909. No. 8854 A.

Tires.

Tyre Problems. D. W. Samways. Read before the Roy. Auto. Club. Analyses the forces acting upon the rim and wheel, and discusses the advantages of a high tyre over a low one. 2000 w. Auto Jour—Oct. 16, 1909. No. 8853 A.

Tractors.

Military Steam-Tractor. Illustrates and describes the Stewart steam-tractor. 1000 w. Engng—Oct. 15, 1909. No. 8898 A.

Tractor or Motor Wagon. A discussion of tractors and steam lorries, their suitability, cost, and working costs. 2000 w. Mech Wld—Oct. 8, 1909. Serial. 1st part. No. 8886 A.

Wheels.

An Important Dunlop Departure. Illustrates and describes a detachable wheel introduced by this firm. 1500 w. Auto Jour—Oct. 2, 1909. No. 8471 A.

The Sizes of Wheels in Motor Vehicles. Discusses the considerations which determine the size of wheels used in various vehicles, and the effect of size on efficiency. 3000 w. Engng—Oct. 1, 1909. No. 8489 A.

COMBUSTION MOTORS.

Carburetters.

A New Automatic Carburetter. Illustrated description of the design known as the Polyshoe carburetter. 700 w. Engr, Lond—Oct. 8, 1909. No. 8943 A.

Gas Engines.

The Influence of Compression Pressure Upon Thermal Efficiencies of Gas-Engines. W. A. Tookey. Letter discussing Prof. Burstall's reports on behalf of the Gas-Engine Research Committee, 3000 w. Engng—Oct. 15, 1909. No. 8899 A.

Gas Engines. Mark B. Lamb. Brief description of the Gary plant. Ills. 1700 w. Min & Sci Pr—Oct. 2, 1909. No. 8409.

The Cooper Gas Engine. Illustrated detailed description. 900 w. Ir Age—Oct. 14, 1909. No. 8545.

The Nurnberg Gas Engine. Abstract of paper by Richard Bechtel, read before the Birmingham (Eng.) Assn. of Mech. Engrs. Reviews the large internal-combustion engines, particularly the Nurnberg engine. Ills. 2500 w. Cassier's Mag—Oct., 1909. No. 8468 B.

See also Gasoline Engines, under COMBUSTION MOTORS; and Isolated Plants, under ELECTRICAL ENGINEERING, GENERATING STATIONS.

Gasoline Engines.

Another British Flight Engine. Illustrated description of G. de Havilland's 45-h. p. model, weighing 250 lbs. complete. 1000 w. Auto Jour—Sept. 25, 1909. No. 8336 A.

A Variable Stroke Petrol Engine. Illustrates and describes a new variable stroke engine and direct drive, stating some of its advantages. 1000 w. Engr, Lond—Oct. 15, 1909. No. 8949 A.

Remodeling Gasoline (Petrol) Engines for Producer Gas. H. F. Smith. Read before the Nat. Gas and Gasoline Eng. Trds. Assn. (Abstract). States briefly the main points to be considered in an engine designed for producer gas, discussing details. 2500 w. Int Marine Engng—Oct., 1909. No. 8323 C.

Gasoline Engine Testing. James L. Miller. Abstract of paper read before the Glasgow Tech. Col. Sci. Soc. Describes the works testing of finished gasoline engines. 1800 w. Gas Engine—Oct., 1909. No. 8524.

Gas Power Plants.

Power Plant Design for Gas Power. H. R. Linn. Thesis for degree of Mech. Eng. at University of Ill., which discusses history, development and application of gas engines for power plants and design of plants. 8500 w. Indus Engng—Oct. 15, 1909. No. 8575 B.

Small Isolated Producer-Gas Power Plant. Osborn T. Monnett. Illustrated description of a very efficient installation at Milwaukee. 1500 w. Power—Oct. 26, 1909. No. 8774.

We supply copies of these articles. See page 487.

Gas Producers.

Gas Producer Plant for Bituminous Coal. Illustrates and describes an experimental plant in Gloucester that seems satisfactory. 1200 w. Engr, Lond—Sept. 24, 1909. No. 8369 A.

Gas Turbines.

A Practical Study of the Gas Turbine (Étude practique de la Turbine à Combustion). Charles Lemale. A discussion of recent investigations and progress. Ills. 2700 w. Tech Mod—Sept., 1909. No. 8618 D.

Oil Engines.

Fuel Consumption, Efficiency and Economy Tests on Sulzer-Diesel Motors (Prové di Consumo, Rendimento e Costo eseguite su Motori Sulzer-Diesel). Emilio Gerli. Reports some recent tests in a generating station. Ills. 2700 w. Monit Tech—Sept. 30, 1909. No. 8640 D.

HEATING AND COOLING.

Air Humidifying.

See Hygrometric Charts, and Ventilation, under HEATING AND COOLING.

Central Plants.

Engineering Aspects of District Steam Heating. H. C. Eddy. Considers the factors involved in the profitable development of district heating. 2000 w. Elec Wld—Oct. 7, 1909. No. 8393.

Heating Buildings in Groups by Contract in Chicago. Illustrated description of the methods of the Illinois Maintenance Co. 2000 w. Elec Wld—Oct. 7, 1909. No. 8392.

Cooling Towers.

Cooling Towers. John Roberts. Deals with cooling water for condensers, giving an illustrated description of a new form of tower devised by the writer. Also discussion. 9500 w. Jour S African Assn of Engrs—Sept., 1909. No. 8823 F.

Fans.

Electric Fans: Their Use and Abuse. Results of investigations into the action of small ventilating fans on the purity of the atmosphere. 1500 w. Elec Engr, Lond—Oct. 1, 1909. No. 8479 A.

Hot-Water Heating.

Calculation of Pipe Sizes in Gravity Hot-Water Heating (Berechnung der Rohrweiten bei Schwerkraftwarmwasserheizungen). H. Recknagel. An elaborate discussion, with many tabular data. Ills. Serial. 1st part. 9000 w. Gesundheits-Ing—Sept. 4, 1909. No. 8685 D.

Hygrometric Charts.

Humidity and Drying Calculations. Gives two useful hygrometric charts, illustrating their use by examples. 2200 w. Heat & Vent Mag—Oct., 1909. No. 8757.

Pipe Corrosion.

Electrolysis of Iron Pipe. F. P. Siebel. Considers particularly the pitting of iron pipe, its causes and possible prevention. Ills. 3000 w. Ice & Refrig—Oct., 1909. No. 8316 C.

Corrosion vs. So-Called Corrosion. W. A. Bradford. The effect of water and other destructive agents on various kinds of pipe. 2500 w. Met Work—Oct. 2, 1909. No. 8244.

Piping.

See Shafting, under POWER AND TRANSMISSION.

Refrigeration.

Efficiency of Refrigerating Machines. Dr. J. E. Siebel. Considers the results of tests made by Prof. Schroeter, in Munich. 2500 w. Ice & Refrig—Oct., 1909. Serial. 1st part. No. 8315 C.

A Modern Ice Plant in Chicago. Carl Heim. Illustrated description of the model Edgewater plant of the Knickerbocker Co., with cost data and other plant records. 4000 w. Power—Oct. 26, 1909. No. 8773.

Humidity and a Cold Storage Evaporimeter. Description of instrument invented by Milo M. Hastings, U. S. Dept. of Agriculture, to determine humidity available for use in the cold storage of fruits. Ill. 3000 w. Cold Stor & Ice—Oct., 1909. No. 8573 C.

See also Air Compression, and Gas Compression, under POWER AND TRANSMISSION; and Refrigeration, under MARINE AND NAVAL ENGINEERING.

Steam Heating.

Steam Heating in Connection with Central Stations. Abstract of a paper presented at the Penn. Elec. Assn. convention, discussing district heating from electrical plants. 1500 w. Elec Wld—Oct. 7, 1909. No. 8394.

Heating and Ventilating a Six-Room School Building. Charles L. Hubbard. Describes a simple gravity system of indirect heating for class rooms, and direct radiation in corridors and coat rooms. Ills. 2500 w. Met Work—Oct. 23, 1909. No. 8710.

Heating and Ventilation in the Ford Building, Detroit. An 18-story steel-cap building, receiving its steam, electric, compressed air and refrigerating service from an outside source is described. Plan of arrangement is given. 1800 w. Eng Rec—Oct. 16, 1909. No. 8598.

See also Valves, under STEAM ENGINEERING.

Ventilation.

Ventilating and Humidifying a Flax Mill. Describes the method of solving this problem at the factory of the Boston Thread & Twine Co. 1200 w. Heat & Vent Mag—Oct., 1909. No. 8756.

Modern Systems of Heating, Ventilating, Humidifying and Cooling the Air of Buildings (I moderni Sistemi di Riscaldamento, Ventilazione, Inumidimento e Refrigeramento dell' Aria). Salvatore Spera. A brief general review of modern practice. 4000 w. Monit Tech—Sept. 10, 1909. No. 8637 D.

We supply copies of these articles. See page 487.

HYDRAULIC MACHINERY.

Centrifugal Pumps.

A Note on the Theory of the Centrifugal Pump (Beitrag zur Theorie der Zentrifugalpumpen). G. Zerkowitz. Mathematical. 5500 w. Zeitschr d Oest Ing u Arch Ver—Sept. 24, 1909. No. 8692 D.

Hydrodynamics.

Incorrect Application of Hydraulic Principles (Ueber unrichtige Anwendung hydraulischer Sätze). Donat Banki. A mathematical criticism of certain errors in hydraulic literature. Ills. 5500 w. Zeitschr d Ver Deutscher Ing—Sept. 11, 1909. No. 8914 D.

Pumps.

The Humphrey Gas-Pump. Illustrated description of a novel gas-pumping plant, with report of tests made at Dudley Port, by Prof. W. Cawthorne Unwin. 3800 w. Engng—Oct. 15, 1909. No. 8930 A.

Pump Valves.

Pump Valves and Valve Areas. A. F. Nagle. Aims to show that the proportioning the valve area to the plunger area is defective. A critical study. 2500 w. Jour Am Soc of Mech Engrs—Mid-Oct., 1909. No. 8749 F.

Surge Tanks.

The Stand Pipe in Water Power Plants. Irving P. Church. An investigation of the height of surge occurring in the stand pipe, as well as the drop, when the gates are suddenly opened. 2500 w. Cornell Civ Engr—Oct., 1909. No. 8840 C.

Turbine Efficiency.

The Relation of the Efficiency of Water Turbines to Fall, Temperature of Water, Size of Turbines and Roughness of Conduit (Die Abhängigheit des Wirkungsgrades des Wasserturbinen von Gefälle, Wasserwärme, Turbinengrösse und Rauheit der Kanäle). Dr. Camerer. Mathematical. 3000 w. Zeitschr d Ver Deutscher Ing. No. 8916 D.

Turbine Measurements.

Measurements on Turbine Conduits (Quelques Mesures effectuées sur les Canaux de Turbines). J. F. Audouin. A translation of H. Jaeger's paper in the *Zeitschrift für das gesamte Turbinenwesen*. Ills. Serial. 1st part. 1200 w. Rev Indus—Sept. 11, 1909. No. 8624 D.

Turbines.

High-Speed Francis Turbines (Francisturbinen-Schnelläufer). Ernst Reichel. A review of American and European practice. Ills. 2300 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 30, 1909. No. 8678 D.

MACHINE ELEMENTS AND DESIGN.

Ball Bearings.

Ball Bearings in the Construction of Ship Machinery (Kugellager im Schiffsmaschinenbau). Illustrates a number of applications. 2000 w. Schiffbau—Sept. 8, 1909. No. 8668 D.

Clutches.

Formulas for Cone Clutches. Gives formulas and data sheet containing summary. 500 w. Mach, N Y—Oct., 1909. No. 8285 C.

Friction Clutches to Operate Reciprocating Machines. Thomas R. Shaw. Suggests a method of operating friction clutches so as to engage in a pre-determined time. Ills. 1000 w. Mech Engr—Oct. 15, 1909. No. 8880 A.

Crane Hooks.

An Investigation of Strength of Crane Hooks. Walter Rautenstrauch. Results obtained by a theoretical study are closely checked by tests of seven hooks ranging from 2 to 30 tons capacity. Diagrams. 2500 w. Am Mach—Vol 32, No. 40. No. 8389.

The Design of Curved Machine Members Under Eccentric Load. Prof. Walter Rautenstrauch. Reports an investigation of crane hooks as an example of a curved beam, developing formulæ. 1000 w. Jour Am Soc of Mech Engrs—Mid-Oct., 1909. No. 8752 F.

Fly-Wheels.

Simplified Methods for Fly-Wheel Calculations. R. J. Williams. Mathematical. 700 w. Mach, N Y—Oct., 1909. No. 8288 C.

Gears.

Epicyclic Trains of Wheels. H. G. Taylor. Explains the rules regarding such wheels. 1000 w. Prac Engr—Oct. 15, 1909. No. 8874 A.

See also same title, under AUTOMOBILES.

Graphics.

Centres of Gravity and Moments of Inertia by Christian Nehl's Graphic Method. A short review of Nehl's method, with suggestions for simplification and also a few theoretical applications. 1100 w. Cornell Civ Engr—Oct., 1909. No. 8841 C.

Gyroscope.

The Gyroscope and Its Applications (Studio sul Giroscopio e le sue Applicazioni). L. Silla. An exhaustive discussion. Ills. Serial. 1st part. 9000 w. Ann d Soc d Ing e d Arch Ital—Sept. 1, 1909. No. 8636 F.

Rivet Holes.

The Influence of Rivet Holes on the Axial Deformation of Steel Rods (Der Einfluss der Nietlöcher auf die axiale Formänderung gezogener Stäbe). Paul Müller. Mathematical. Ills. 1800 w. Zeitschr d Ver Deutscher Ing—Sept. 4, 1909. No. 8911 D.

Rivetted Joints.

Notes on Strength of Rivetted Joints. H. S. Jeffery. Aims to show the real need of considering the factor of safety in the calculation of the strength of boilers. 8000 w. Boiler Maker—Oct., 1909. No. 8379.

We supply copies of these articles. See page 487.

Shocks.

Stresses Produced by Shocks. A. P. Eltoft. Aims to give a clearer understanding of the principles involved in stresses produced by shocks. 1400 w. Mach, N Y—Oct., 1909. No. 8280 C.

Thrust Bearings.

Graphical Solution of Thrust-Bearing Problems. George E. Barrett. 700 w. Int Marine Engng—Oct., 1909. No. 8326 C.

MACHINE WORKS AND FOUNDRIES.

Assembling.

Assembling Machine Tool Units. Alfred Spangenberg. An illustrated consideration of concrete examples, applying principles set forth in a previous article. 4000 w. Mach, N Y—Oct., 1909. No. 8284 C.

Efficient System for the Rapid Assembling of Motor Cars. Harold Whiting Slauson. Describes the assembling rooms of the Chalmers-Detroit Motor Car Co. Ills. 1800 w. Mach, N Y—Oct., 1909. No. 8283 C.

Blacksmithing.

Suggestions for a Model Blacksmith Shop. James Cran. Plans and description of building and arrangements. 4000 w. Mach, N Y—Oct., 1909. No. 8282 C.

Bolt Making.

An Up-Setting Machine for Bolts, Rivets, etc. (Machine à Refouler pour Boulons, Rivets, etc.). Illustrated detailed description of an automatic machine for making bolts and rivets from bar iron. 2000 w. Serial. 2 parts. Métallurgie—Sept. 22 and 29, 1909. No. 8625 each D.

Brass Founding.

Cost of Manufacturing Valves, Hydrants, and Brass Goods in Municipal Shops for the Boston Water Works. Gives results of a recent investigation of shops operated by the city. 2500 w. Engng-Con—Sept. 29, 1909. No. 8232.

The Ohio Brass Company's Plant at Mansfield, Ohio. Description of foundries and other buildings of a modern plant for manufacturing brass specialties. Ills. 3500 w. Indus Engng—Oct. 15, 1909. No. 8574 B.

Castings.

Correct Metal for Castings. Almon Emrie. Illustrated description of a method for obtaining the right kind of metal from the cupola, in the correct amounts. 700 w. Am Mach—Vol. 32, No. 40. No. 8391.

Cupola Practice.

Fluxes for Melting Iron. Information regarding the chemical action and influence of fluxes in cupola melting. 2000 w. Ir & Coal Trds Rev—Oct. 1, 1909. No. 8957 A.

Mixing Irons for the Cupola (Eisengattierung für den Kupolofen). Leo Hemmer. Discusses the general principles in the proportioning of cupola mixtures. 3500 w. Serial. 2 parts. Giesserei-Zeit—Sept. 1 and 15, 1909. No. 8656 each D.

Dies.

Drawing Dies for Hollow Rivets. Charles Welslow. Illustrated description of the work done. 1200 w. Mach, N Y—Oct., 1909. No. 8290 C.

Drilling Machines.

Combined Slotting and Drilling-Machine. Illustrated description of a heavy machine constructed at the Ernst Schiess works, Dusseldorf. 500 w. Engng—Sept. 24, 1909. No. 8362 A.

Foundries.

European and American Foundries. W. H. Dooley. A comparison of the casting plants of Germany, Belgium, England, and Switzerland with those of the United States. 2500 w. Foundry—Oct., 1909. No. 8294.

The Works of the Sandycroft Foundry Company Limited. Illustrated description of remodeled works and the products manufactured, especially the electromotors for mining purposes. 2000 w. Col Guard—Oct. 15, 1909. No. 8891 A.

Furnaces.

Crucible Furnaces Without Chimneys. Walter J. May. Directions for a crucible furnace with forced draught. Ills. 800 w. Prac Engr—Oct. 1, 1909. No. 8472 A.

Lathes.

Capstan Lathe. Illustrated description of a new type built in England. 500 w. Engng—Oct. 8, 1909. No. 8892 A.

Wheel and Tyre Lathes. Illustrated description of the latest design of Messrs. G. & A. Harvey, Ltd., of this tool for turning the wheels of locomotives, boring tyres, or turning bosses. 400 w. Engng—Oct. 15, 1909. No. 8931 A.

Machine Tools.

An Early Chapter in Machine Tool Design. Gives tracings made by James Nasmyth & Co., and Joseph Whitworth & Co., in the years 1856 & 1857, with descriptions. 1000 w. Am Mach—Vol. 32, No. 41. No. 8709.

Portable Tools Electrically Driven. S. R. Stone. Illustrates and describes shapers, planers, drill presses, special combination and ball socket boring machines as portable tools used in Cincinnati shops of the Allis-Chalmers Co. 3000 w. Am Mach—Vol. 32. No. 42. No. 8806.

See also Shop Practice, under MACHINE WORKS AND FOUNDRIES.

Molding.

Molding Large Gray Iron Castings. Illustrates and describes the method of molding and casting 115-ton engine frames, and the problem of handling these large sections. 1800 w. Foundry—Oct., 1909. No. 8292.

A New Propeller Molding Method. J. F. Buchanan. An economical improved

We supply copies of these articles. See page 487.

method of making propeller wheels is illustrated and described. 1000 w. Foundry—Oct., 1909. No. 8296.

Molding Sand.

Molding Sand and Its Automatic Preparation (Formsand und automatische Sandaufbereitungen). Describes modern apparatus and plants. Ills. 3200 w. Giesserei-Zeit—Sept. 1, 1909. No. 8657 D.

Patterns.

A Forging Machine Frame Pattern. Jabez Nall. Illustrated description of how it was made to effect the greatest economies in the foundry. 2500 w. Foundry—Oct., 1909. No. 8295.

Pipe Drawing.

Making Shelby Seamless Steel Tubes. R. S. Bayard. Illustrated description of method of transforming a solid steel billet into a seamless tube. 6000 w. Am Mach—Vol. 32. No. 40. No. 8386.

Shop Design.

The Planning and Building of Industrial Plants. Charles Day. This third article of a series considers the financing and preparation of detail plans and specifications. 7000 w. Engineering Magazine —Nov., 1909. No. 8834 B.

Shop Lighting.

The Principles of Shop Lighting. J. H. Stickney. Outline of Available Systems with chief characteristics of each. Ills. 3000 w. Indus Engng—Oct. 15, 1909. No. 8578 B.

Shop Practice

Machining Sluice Valve Body and Plug. H. Pearman. Prize paper. Illustrated directions for the work. 1200 w. Mech Wld—Oct. 15, 1909. No. 8887 A.

The Design and Manufacture of a High-Grade Motor Car. Ralph E. Flanders. Illustrated detailed description of the factory, methods, and products of the Stevens-Duryea Co. 7000 w. Mach, N Y—Oct., 1909. No. 8279 C.

Automobile Factory Practice. Ethan Viall. Illustrated detailed description of methods used by the Dayton Motor Car Co. 2500 w. Mach, N Y—Oct., 1909. No. 8281 C.

Special Machinery Used in Making Automobiles. Thomas J. Fay. An illustrated article giving information in regard to the processes and special tools used in this work. 2500 w. Automobile—Oct. 7, 1909. No. 8418.

Building the Franklin Automobiles. Illustrates and describes some of the tools, fixtures and methods used in building these air-cooled cars. 2500 w. Am Mach —Vol. 32. No. 41. No. 8800.

Shops.

The Woolwich Works of Siemens Bros. & Company, Limited. Illustrated detailed description. 3500 w. Ir & Coal Trds Rev —Oct. 1, 1909. No. 8955 A.

Woolwich Arsenal. Illustrated description of the Royal Arsenal at Woolwich. 3500 w. Ir & Coal Trds Rev—Oct. 1, 1909. No. 8954 A.

New Works at Wolverhampton. Illustrated description of the new plant of Chubb & Son's Lock and Safe Co. 2500 w. Engr, Lond—Oct. 15, 1909. No. 8948 A.

Welding.

Marine Boiler Repairs by the Oxy-Acetylene Process. James Crombie. Describes repairs recently made on the steamship "Spray I." Ills. 800 w. Boiler Maker—Oct., 1909. No. 8381.

Theory and Practice of Oxy-Acetylene Welding. J. F. Springer. Description of apparatus and operations of the Davis-Bournerville system. Ills. 8000 w. Indus Engng—Oct. 15, 1909. No. 8580 B.

Wood-Working Machines.

Wood-Worker. Illustrated description of a wood-working machine of English make. 700 w. Engng—Oct. 8, 1909. No. 8894 A.

MATERIALS OF CONSTRUCTION.

Alloys.

Some Physical Characteristics of Iron Alloys. Charles F. Burgess and James Aston. Reports results of an investigation being conducted in the laboratories of the Univ. of Wis. testing the forgeability, welding, and machining of practically carbon-free iron alloys. 2000 w. Elec-Chem & Met Ind—Oct., 1909. No. 8330 C.

Alloy Steels.

The Constitution of Carbon-Tungsten Steels. Thomas Swinden. Read before the Ir. & St. Inst. A continuation of research work previously reported. Ills. 7500 w. Ir & Coal Trds Rev—Oct. 1, 1909. No. 8952 A.

Qualities and Characteristics of the New Steels (Beschaffenheit und Charakteristik der neuen Stahlsorten). W. Heym. Gives in brief form the qualities imparted to steel by the addition of the alloy metals. Serial. 1st part. 1800 w. Geisserei-Zeit—Sept. 15, 1909. No. 8659 D.

Cast Iron.

Influence of Chemical Compounds on the Properties of Cast Iron. A. H. Hiorns. Read before the British Found. Assn. Investigates the influence of chemical compounds on soundness of castings. 2000 w. Mech Wld—Oct. 8, 1909. Serial. 1st part. No. 8885 A.

The "Growth" of Cast Irons after Repeated Heatings. Prof. H. F. Rugan, and Prof. H. C. H. Carpenter. Read before the Ir. & St. Inst. Ills. 18500 w. Ir & Coal Trds Rev—Oct. 1, 1909. No. 8953 A.

The "Growth" of Cast Iron After Repeated Heatings. An account of recent investigations in Great Britain, with comments by A. E. Outerbridge, Jr. 4000 w. Ir Age—Oct. 7, 1909. No. 8377.

We supply copies of these articles. See page 487.

Tests of Cast Iron. E. Adamson. Read before the Ir. & St. Inst. A report of comparative tests made to arrive at the differences in results under varying working conditions. 2000 w. Engng—Oct. 15, 1909. No. 8935 A.

See also Test Bars, under MEASUREMENT.

Metallography.

The Metallography of Iron Clarified. Henry M. Howe. A new theory as to the nature of the martensite needle structure which also simplifies the metallography of iron. Ills. 4500 w. Elec-Chem & Met Ind—Oct., 1909. No. 8327 C.

Researches on the Sub-Oxides of Cæsium (Recherches sur les Sous-Oxydes de Cæsium). M. Rengade. An investigation of the solution of metallic oxides in fused metals. Ills. 5000 w. Rev de Métal—Sept., 1909. No. 8605 E + F.

Metallographic Examination of Some Semi-Steels (Examen micrographique de quelques Fontes de Moulage dites "Aciéreuses"). Jean Guillemin. Illustrates and describes their structure. 1500 w. Rev de Métal—Sept., 1909. No. 8606 E + F.

Steel.

The Heat Treatment of Spring Steel. Lawford H. Fry. Read at the Copenhagen Congress of the Int. Soc. for Test. Maf. An account of a series of tests made at the Baldwin Locomotive works to determine the effect of certain heat treatments. 2500 w. Ir Age—Oct. 7, 1909. No. 8375.

Tenacity and Malleability. William Misangyi. Presented at Cong. Int. Assn. for Test. Materials. Report of investigations on iron bars, and conclusions. 1600 w. Ir Trd Rev—Oct. 14, 1909. No. 8568.

The Appearance of Fractures and the Quality of Materials (Bruchaussehen und Materialbeschaffenheit). O. Bauer. Experimental data on the estimation of the quality of steel by the grain of the fracture. Ills. 1400 w. Stahl u Eisen—Sept. 1, 1909. No. 8648 D.

MEASUREMENT.

Hardness.

The Hardness of Metals and Its Measurement (La Durezza dei Metalli e relative Metodi di Prova). A review and discussion of the various methods of measuring hardness. Ills. 5000 w. Ing Ferro—Sept. 1, 1909. No. 8641 D.

The Measurement of Hardness (Härtebestimmung). Wolfgang Koch. A description and discussion, with test results, of the Heroult-Shore scleroscope method. Ills. 4000 w. Zeitschr f Werkzeug—Sept. 5, 1909. No. 8684 D.

Impact Test.

The Theory of Impact and Its Application to Testing Materials. Harry D. Tiemann. Reviews some of the relations of dynamics bearing upon this subject and discusses the dynamic stresses, or stresses produced by impact. Mathematical. 5000 w. Jour Fr Inst—Oct., 1909. Serial. 1st part. No. 8523 D.

Laboratories.

The Testing Laboratory of the Conservatoire National des Arts et Métiers (Conservatoire National des Arts et Métiers, Laboratoire d'Essais). L. Guillet. A brief report of its activities during 1908. 3000 w. Rev de Métal—Sept., 1909. No. 8609 E + F.

Micrometers.

The Picard and Colomb Micrometer. Report of the Committee of Economic Arts, of the French Society of Encouragement for National Industry on an instrument intended for easy and rapid measurement of the thickness of objects with parallel sides or the diameter of cylinders. Ills. 1000 w. Am Mach—Vol. 32. No. 40. No. 8390.

Planimeters.

Principle of Planimeter Operation. M. R. Wells. An explanation showing that the planimeter is a device of simple construction and its principle easy to understand. Ills. 1800 w. Am Mach—Vol. 32. No. 42. No. 8805.

Pyrometry.

The Radiation Pyrometer in the Foundry. C. E. Foster. Describes this instrument, explaining its usefulness. 2500 w. Prac Engr—Oct. 15, 1909. No. 8873 A.

Pyrometry of Beehive Coke Ovens. J. R. Campbell. Varieties of apparatus for measuring high temperatures, with data from the ordinary beehive coke oven in the Connellsville region. 4500 w. Mines & Min—Oct., 1909. No. 8256 C.

Rubber Testing.

The Testing of Rubber and Other Materials. Information from a communication by Messrs. K. Memmler and A. Schob, relating to the chemical and mechanical testing of rubber. The Schopper machine was used for ring sample tests. 900 w. Engr, Lond—Oct. 15, 1909. No. 8950 A.

Screw Threads.

A Device for Measuring Screw Threads. M. Eric Anderson. Illustrates and describes roller calipers which can be conveniently adjusted to suit any angle of helix and to measure accurately threads of any lead. 1500 w. Am Mach—Vol. 32. No. 41. No. 8802.

Stresses.

Determining Stresses by Thermo-Electric Measurements. Extracts from a paper by E. Rasch, before the Copenhagen Congress of the Int. Assn. for Test. Materials, describing this method. 1000 w. Eng Rec—Oct. 9, 1909. No. 8443.

Test Bars.

A Report on Cast-Iron Test Bars. A.

We supply copies of these articles. See page 487.

F. Nagle. Gives results of examinations and study of a large number of test-bars. 1700 w. Jour Am Soc of Mech Engrs—Mid-Oct., 1909. No. 8750 F.

Influence of Form and Position on Cast Steel Tensile Test Bars. R. A. Bull. A report of tests made of round and rectangular bars, and of a U-shape test bar. 2000 w. Foundry—Oct., 1909. No. 8293.

Testing Machines.

Recent Testing Machines Built by Mohr & Federhaff, Mannheim (Neuere Festigkeitsmaschinen der Mannheimer Maschinenfabrik Mohr & Federhaff). Georg Wazau. Illustrates a number of machines for various purposes. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Sept. 4, 1909. No. 8909 D.

Venturi Meters.

Tests on a Venturi Meter for Boiler Feed. Prof. C. M. Allen. Report of tests made to determine the accuracy of a Venturi meter to be used for measuring boiler feed under a great variety of conditions. Ills. 1200 w. Jour Am Soc of Mech Engrs—Mid-Oct., 1909. No. 8751 F.

Water.

Measuring Flow of Water by Meter and Weir. Franklin Van Winkle. Describes how to make and use a Venturi meter for measuring flow of water in pipes, the construction of weirs and the theory of flow over a weir. 6000 w. Power—Oct. 5, 1909. No. 8318.

Measurement of Water by the Moving Screen Method (Wassermenge-Messung mittels Schirmes). Wilhelm Müller. Describes the measurement of water flowing in a conduit by means of a screen entirely filling the section of the conduit and carried by a traveller. Ills. Serial. 1st part. 1500 w. Zeitschr f d Gesamte Turbinenwesen—Sept. 30, 1909. No. 8679 D.

See also Venturi Meters, under MEASUREMENT.

POWER AND TRANSMISSION.

Air Compression.

Compressed Air Calculation Short Cuts. Gives a chart by which the mean effective pressure and horsepower may be determined without the use of formulæ involving fractional exponents. 1200 w. Am Mach—Vol. 32. No. 42. No. 8807.

Mean Effective Pressures in Air Compression or Expansion. Frank Richards. Tables and diagrams offering special facilities for power computations. 1500 w. Am Mach—Vol. 32. No. 41. No. 8801.

Mechanical Refrigeration in Air Compression. Joseph H. Hart. On the superiority of the absorption system in compressing air for the transmission and storage of energy. 4000 w. Power—Oct. 12, 1909. No. 8518.

Air Compressors.

The Plant and Equipment of the Cobalt Hydraulic Company. Illustrated description of the Taylor air-compressor plant at Ragged Chutes, on the Montreal River. 800 w. Can Min Jour—Oct. 15, 1909. No. 8796.

Belt Driving.

Belt, Motor and Rope Drive. H. D. Jackson. Criticizes statements made by Harrington Emerson, and examines costs of operating and installing, and some of the troubles with the belt drive. 2200 w. Power—Oct. 12, 1909. No. 8515.

Practical Charts for Dimensioning Pulleys for Belt and Rope Driving (Praktische Arbeitstabellen zur Bestimmungen der Dimensionen bei Riemenscheiben und Seilscheiben). H. Vetter. Gives a number of charts with explanation of their use. Ills. 1500 w. Giesserei-Zeit—Sept. 1, 1909. No. 8658 D.

Steel Bands for Power Transmission. J. P. Schroeter. Describes some German experiments, showing favorable results. 600 w. Eng News—Oct. 14, 1909. No. 8565.

Costs.

The Cost of a Kilowatt-Hour. R. A. Day. A chart showing the items which enter into the cost of a kw.-hour of electrical energy, with explanatory notes. 2000 w. Elec Wld—Oct. 7, 1909. No. 8400.

Electric Driving.

Points to Consider in Choosing a Motor. H. M. Phillips and E. F. Butler. Views of two experienced engineers upon features of construction, speeds, windings, and ratings of direct-current motors. 4500 w. Power—Oct. 26, 1909. No. 8775.

Electric Motors for Industrial Plants. W. E. Crane. Describes motor installation to meet stated conditions, and discusses questions related. 1500 w. Power—Oct. 12, 1909. No. 8519.

The Installation of Electrical Power Plant. J. T. Corner. Deals with the general features and the various types of motors suited to each special kind of machinery, and the gearing of the motor to the machine. 1800 w. Mech Wld—Sept. 24, 1909. No. 8355 A.

Installation, Operation, Care and Repair of Electric Motors in Industrial Operations. C. E. Daniels. Illustrated article giving information of value. 2500 w. Elec Rev, N Y—Oct. 23, 1909. Serial. 1st part. No. 8783.

Electricity in Building Operations. Describes the application of the electric drive to machinery used by builders and contractors. Ills. 2000 w. Elect'n, Lond—Oct. 1, 1909. Serial. 1st part. No. 8485 A.

The Depreciation of Electric Plant. J. T. Corner. Aims to show how rapid deterioration may be prevented. 1500 w. Mech Wld—Oct. 15, 1909. No. 8888 A.

Gas Compressors.

Theory and Construction of Compressor Valves. M. Hirsch. Discusses the causes of loss in operation of gas com-

pression machines and isolated subjects. Diagrams. 1200 w. Ice & Refrig—Oct., 1909. No. 8314 C.

Lubrication.

Some Experiments on Lubrication. W. W. F. Pullen and W. T. Finley. Describes experiments undertaken to determine how far some of the mechanical properties of a lubricant might influence its selection for a particular purpose. 2000 w. Mech Engr—Oct. 15, 1909. Serial. 1st part. No. 8884 A.

Some Tests of Grease Lubrication. A report of tests made at Cornell University to determine the ability to endure extreme bearing pressure. 1400 w. Am Mach—Vol. 32. No. 40. No. 8388.

Power Plants.

Power Plant Waste. Percival R. Moses. Calls attention to losses easily prevented. 5000 w. Cassier's Mag—Oct., 1909. Serial. 1st part. No. 8462 B.

Power Plants, American La France Fire Engine Company. Detailed description of a plant in Elmira, N. Y., supplying a group of buildings. Plan. 3000 w. Eng Rec—Oct. 9, 1909. No. 8444.

Rope Driving.

The Gearing of Modern Cotton Spinning Mills. The remarks usually apply to either the Blackburn or Oldham district, but are of universal application. Rope-driving only is discussed. 1000 w. Mech Wld—Oct. 1, 1909. Serial. 1st part. No. 8476 A.

See also Belt Driving, under POWER AND TRANSMISSION.

Shafting.

Methods of Attaching Shafting, Piping, Etc., to Reinforced Concrete Buildings. Gives sketches of a variety of forms of hangers for both shafting and piping, with description. 1000 w. Engng-Con—Sept. 29, 1909. No. 8229.

Wind Power.

Some Ancient Windmills on Cape Cod. Snowden B. Redfield. Illustrates and describes wonderfully well-preserved examples of mechanical skill. 4000 w. Am Mach—Vol. 32. No. 42. No. 8803.

STEAM ENGINEERING.

Boiler Design.

The Best Form of Longitudinal Joint for Boilers. F. W. Dean. Describes a recommended joint with both straps of the same width. 1000 w. Jour Am Soc of Mech Engrs—Oct., 1909. No. 8531 F.

Boiler Draft.

Mechanical Draft. Charles L. Hubbard. Presents the advantages of mechanical draft and discusses the three systems in common use with stationary boilers. 2000 w. Elec Rev, N Y—Oct. 23, 1909. No. 8781.

Boiler Explosions.

Compound Boiler Explosions Due to Blocking of Openings to Safety Valves. Editorial on the explosion at Distington, and details of two cases taken from the report of L. E. Fletcher. Ills. 7000 w. Mech Engr—Oct. 8, 1909. No. 8879 A.

Accidents in Boiler Practice (Unfälle im Dampfkesselbetriebe). A report on boiler explosions in the Dartmund-Essen district, Germany. Ills. 2500 w. Glückauf—Sept. 4, 1909. 8662 D.

Notes on the Explosion of Two Boilers at Eigelshoven (Opmerkingen over de Ontploffing van twee Stoomketels te Eygelshoven). Two articles, by F. van Iterson and Chr. Hovestad. Ills. 5000 w. De Ingenieur—Sept. 4, 1909. No. 8919 D.

Boiler Feeding.

See Venturi Meters, under MEASURE-

Boiler Fittings.

Water Columns and Methods of Connection. W. H. Wakeman. Illustrates and describes a method of connecting water columns to steam boilers. 1200 w. Power—Oct. 12, 1909. No. 8517.

Boiler Furnaces.

An Interesting Method of Renewing a Furnace in a Scotch Boiler. Neil B. Mair. Outlines the usual methods adopted, and describes in detail an economical method of doing the work when economy and dispatch are demanded. Ills. 1000 w. Boiler Maker—Oct., 1909. No. 8378.

Boiler Leakage.

An Experience with Leaky Vertical Fire-Tube Boilers. F. W. Dean. Gives experience and probable cause of the leakage, with the remedy. Ills. 1800 w. Jour Am Soc of Mech Engrs—Oct., 1909. No. 8532 F.

Boiler Management.

Utilization of Waste Heat in Firing with Bituminous Coal (Ueber die Verwertung der Abhitze von Steinkohlen-Feuerungen). M. Kaufhold. Discusses methods of more economical utilization of coal. Ills. 2800 w. Stahl u Eisen—Sept. 1, 1909. No. 8650 D.

Boilers.

Sectional Boilers (Gliederkessel). Herr Pradel. An exhaustive discussion of their design and of existing types. Ills. Serial. 1st part. 3000 w. Gesundheits-Ing—Sept. 25, 1909. No. 8688 D.

High-Capacity Water-Tube Boiler with Induced Draught in the Schöneberg Station of the Elektricitätswerk-Südwest-A.-G. (Hochleistungs-Wasserrohrkessel mit Saugzuganlage im Kraftwerk Schöneberg der Elektricitätswerk-Südwest-A.-G.) Herr Generlich. Illustrated description with test results. 1800 w. Zeitschr d Ver Deutscher Ing—Sept. 4, 1909. No. 8910 D.

Boiler Theory.

Heat Transmission. W. E. Dalby. Research work with the aim of presenting a general view of the work which has been done relating to the transmission of heat across boiler heating surfaces. 12000 w. Inst of Mech Engrs—Oct. 15, 1909. No. 8763 N.

We supply copies of these articles. See page 487.

Condensers.

The Consummate Evaporative Condenser. Illustrated description of this condenser as installed in the Bermondsey supply station, with some figures of tests and costs. 800 w. Engr, Lond—Oct. 1, 1909. No. 8498 A.

See also Steam Engines, under MARINE AND NAVAL ENGINEERING.

Engine Cylinders.

Cylinder Condensation and the Temperature of Cylinder Walls. R. Royds. A theoretical and experimental study of the receptivity and emissivity of a surface in contact with steam. 3500 w. Engr, Lond—Oct. 15, 1909. No. 8945 A.

Engine Defects.

Discoveries of Engineers. W. H. Wakeman. Experiences of operating engineers, describing causes and remedies of defects. Ills. 3500 w. Power—Oct. 19, 1909. No. 8769.

Engine Design.

The Design of Turning Engines. Edward M. Bragg. Discusses important details in the design. Ills. 2200 w. Int Marine Engng—Oct., 1909. No. 8324 C.

Engine Foundations.

Building an Engine Foundation. Notes on the building of a typical concrete foundation, to carry a large high-speed engine and generator. Ills. 1800 w. Elec Rev, Lond—Sept. 24, 1909. No. 8342 A.

Engine Governors.

Engine Governors. William Matthews. A short discourse on the requirements, size, power, etc., of governors necessary to control engines or engine valve gear. Ills. 1200 w. Prac Engr—Oct. 1, 1909. Serial. 1st part. No. 8473 A.

Engines.

A New Experimental Engine. Illustrated description of an experimental engine of the drop valve type. 700 w. Engr, Lond—Oct. 15, 1909. No. 8951 A.

Tandem Compound Condensing Semi-Portable Engine. An illustrated description of Wolf's semi-portable engine, with report of tests undertaken to ascertain the steam and coal consumption, efficiency, and general working. 3000 w. Engng—Oct. 8, 1909. No. 8893 A.

Fuel Purchasing.

Efficiency in the Purchase of Fuel for Power Generation. Walter N. Polakov. Discussion of wastes and their prevention. 3500 w. Engineering Magazine—Nov., 1909. No. 8833 B.

The Purchase of Coal by the B. t. u. Method. Samuel A. Taylor. Read before Am. Min. Cong. A study of the significance and consequences of putting this method of purchase into practical operation. 3500 w. Min Wld—Oct. 9, 1909. No. 8460.

Fuels.

An Experimental Study of Bagasse and Bagasse Furnaces. E. W. Kerr and E. M. Percy. Reports and investigation of the methods of utilizing the heat from this fuel, and the furnace used. Ills. 40000 w. Louisiana Bul No. 117—Aug., 1909. No. 8504 N.

Tan Bark as a Boiler Fuel. David Moffat Myers. Considers the characteristics of wet spent tan bark as a boiler fuel. 6500 w. Jour Am Soc of Mech Engrs—Oct., 1909. No. 8530 F.

Efficiency of Domestic Fuels. John H. Wyman. Report of a series of tests made at Ann Arbor, Mich., for the purpose of ascertaining the relative value of commercial fuels as used in house heating boilers. Discussion. 4000 w. Pro Age—Oct. 1, 1909. No. 8242.

See also Texas, under MINING AND METALLURGY, COAL AND COKE.

Heat Transmission.

See Boiler Theory, under STEAM ENGINEERING.

Injectors.

Researches on the Operation of Injectors (Recherches sur le Fonctionnement des Injecteurs). G. Schrauff. Describes tests on Körting and Siemens injectors and gives results. Ills. 8500 w. Rev de Mécan—Sept., 1909. No. 8603 E + F.

Smoke Prevention.

Industrial Smoke Prevention in Hamburg. John B. C. Kershaw. Information in regard to the work of the Hamburg Smoke Abatement Society. 1800 w. Elec Rev, N Y—Oct. 23, 1909 No. 8782.

The Relation of the Character of Coals to the Prevention of Smoke. D. T. Randall. Read at Syracuse meeting of the Int. Assn. for the Prevention of Smoke. Gives analyses of fuels, discussing furnace conditions and management, and related matters. 1800 w. Boiler Maker—Oct., 1909. No. 8380.

Steam Pipes.

The Action of Air and Steam on Pure Iron. J. Newton Friend. Read before the Iron & Steel Inst. A report of research work. 3000 w. Engng—Oct. 15, 1909. No. 8933 A.

Steam Properties.

The Basis of Engine and Boiler Calculations. A critical discussion of methods used. 1500 w. Mech Engr—Oct. 15, 1909. No. 8881 A.

Turbines.

Steam Turbines. Gerald Stoney. Considers the subject of steam turbines and their development during the last 25 years, briefly discussing prime movers in general. Ills. 9500 w. Jour Soc of Arts—Oct. 8, and 15, 1909. Serial. 2 parts. No. 8824 each A.

A New Impulse Steam Turbine. A 1100 brake horse-power impulse turbine of the multiple-velocity type is illustrated and described. 1800 w. Engr, Lond—Sept. 24, 1909. No. 8370 A.

We supply copies of these articles. See page 487.

The Oerlikon Steam Turbine (Dampfturbine Oerlikon). Illustrated detailed description. 2200 w. Die Turbine—Sept. 5, 1909. No. 8675 D.

Low Pressure and Mixed Turbines. Examples of installations of Rateau apparatus with information related. 1500 w. Power—Oct. 19, 1909. No. 8770.

Exhaust Steam Turbines. J. W. Kirkland. Explains how the exhaust, or low pressure, steam turbine makes it possible to transform to useful work the available energy of steam in the lower pressure ranges, and electric power produced at less cost. Ills. Discussion. 5000 w. Jour S African Assn of Engineers—Aug., 1909. No. 8333 F.

The Utilization of Exhaust Steam in Collieries. C. B. Charters. Read before the S. Wales Inst. of Engrs. Its use in low-pressure turbines driving dynamos for supplying electrical energy is discussed. 5000 w. Mech Engr—Sept. 24, 1909. No. 8354 A.

The Low Pressure Turbine Combined with the Steam Engine. Edwin D. Dreyfus. A study of the application of the low-pressure turbine under certain definite conditions, showing a method of determining the relation between the various elements considered which will give the most satisfactory operation. Ills. 3000 w. Elec Jour—Oct., 1909. No. 8526.

See also Hoisting Engines, under MINING AND METALLURGY, MINING.

Turning Engines.

See Engine Designs, under STEAM ENGINEERING.

Valves.

A New Type of Steam Regulator Valve. Illustrated description of the Servo steam regulator valve. 1000 w. Engr, Lond—Oct. 8, 1909. No. 8944 A.

Misuse of Pressure Reducing and Regulating Valves in Steam Service. A. W. Cash. Discusses the use and misuse of valves, illustrating by examples. 2000 w. Heat & Vent Mag—Oct., 1909. No. 8755.

TRANSPORTING AND CONVEYING.

Aerial Tramways.

Aerial Tramway for a Harz Lime Works. Illustrated description of an aerial tramway with a capacity of 75 tons per hour designed to withstand winter weather. 2000 w. Indus Engng—Oct. 15, 1909. No. 8576 B.

Electrical Suspension Railways in Foundries (Elektrische Hängebahnen in Giessereien). Otto S. Schmidt. Describes a number of recent installations. Ills. 2700 w. Stahl u Eisen—Sept. 8, 1909. No. 8652 D.

Cableways.

Automatic Aerial Wire Ropeway at Stanton Iron Works. Illustrated description. 400 w. Ir & Coal Trds Rev—Oct. 8, 1909. No. 8958 A.

Car Dumping.

See Freight Handling, under TRANSPORTING AND CONVEYING.

Coal Handling.

Coal and Ore Loading Plants, New Rhine Harbor. J. B. Van Brussel. Illustrated description of a German plant comprising six swing, two double jib, and two bridge cranes. 1200 w. Eng & Min Jour—Oct. 16, 1909. No. 8719.

Modern Coal Storage and Reloading Plants in Upper Silesia (Einige moderne Haldenstürz- und Wiederverladeeinrichtungen auf oberschlesischen Steinkohlengruben). Herr Nahnsen. Describes a number of notable installations. 6200 w. Ills. Glückauf—Sept. 18, 1909. No. 8664 D.

See also Docks, under CIVIL ENGINEERING, WATERWAYS AND HARBORS; and Mine Conveyors, under MINING AND METALLURGY, COAL AND COKE.

Conveyors.

New Devices for the Handling of Materials in Horizontal and Slightly Inclined Planes (Neuere Hilfsmittel für den Massentransport in horizontaler und leicht geneigter Ebene). Hubert Hermanns. Describes a number of portable and stationary conveyors. Ills. 2500 w. Stahl u Eisen—Sept. 1, 1909. No. 8649 D.

Cranes.

Four-Motor Overhead Electric Travelling Crane. Illustrations, with brief description of a crane built in Liverpool. 400 w. Engng—Sept. 24, 1909. No. 8364 A.

Dock Machinery.

Electrically-Driven Machinery at Fishguard Harbor. Illustrated detailed description of the harbor machinery installed. 3500 w. Elect'n, Lond—Sept. 24, 1909. No. 8346 A.

Elevator Accidents.

The Hydraulic Lift Accident on the City and South London Railway. Board of Trade report of an inquiry into the circumstances of the accident on Aug. 2, at the Oval Station. 3000 w. Mech Engr—Sept. 24, 1909. No. 8353 A.

Freight Handling.

The Handling of Railway Freight in Bulk (Die Verladung von Massengütern im Eisenbahnbetrieb). Prof. Aumund. The serial begins with a review of car-dumping devices. Ills. Serial. 1st part. 4500 w. Zeitschr d Ver Deutscher Ing—Sept. 4, 1909. No. 8908 D.

Grain Handling.

Grain-Conveying Machinery at Avonmouth Dock. Illustrated description of a recent installation at the Royal Edward dock, Bristol. 1200 w. Engr, Lond—Sept. 24, 1909. No. 8371 A.

Ore Handling.

Ore Handling on the Atlantic Coast. H. Penton. An illustrated article describing the improved modern equipment displacing the older methods. 2200 w. Ir Trd Rev—Oct. 7, 1909. No. 8408.

We supply copies of these articles. See page 487.

Ore Handling on the Atlantic Coast. An illustrated article, describing old methods and the improved modern equipment that is displacing them. 2000 w. Marine Rev—Oct., 1909. No. 8549.

See Coal Handling, under TRANSPORTING AND CONVEYING; Steamships, under MARINE AND NAVAL ENGINEERING; and Ore Handling, under MINING AND METALLURGY, MINING.

MISCELLANY.

Aeronautics.

The Aerodynamic Institute of Kutchino. Illustrated description of a Russian laboratory equipped for students of aeronautics. Translation from *La Nature*. 3500 w. Sci Am Sup—Oct. 16, 1909. No. 8583.

Balloons and Dirigibles in War. H. L. Hawthorne. Discusses the type of weapon to be used against these airships and the character of the ammunition. 3000 w. Jour U S Art—Sept.-Oct., 1909. No. 8505 D.

Lightning and the Airship. L. Zehnder. On the dangers of atmospheric electricity in aeronautics. 1500 w. Sci Am Sup—Oct. 9, 1909. No. 8414.

The Purification of Hydrogen for Use in Aerstatics (L'Epuration de l'Hydrogène destiné à l'Aérostation). Captain Do. A complete practical discussion. Ills. Serial. 1st part. 2000 w. Tech Mod—Sept., 1909. No. 8615 D.

Glenn H. Curtiss. An illustrated account of the man, his aeroplane, and the motor. 2000 w. Mach, N Y—Oct., 1909. No. 8289 C.

Details of the Antoinette Monoplane. Augustus Post. Illustrated description of the invention of León Levavasseur. 3000 w. Am Mach—Vol. 32. No. 40. No. 8387.

The Aviation Week at Rheims (La Semaine d'Aviation de Rheims). Describes in detail the aeroplanes, the events, etc. Ills. 9000 w. Génie Civil—Sept. 4, 1909. No. 8626 D.

The Week of Aviation in Champagne (La grande Semaine d'Aviation de Champagne). L. Marchis. Detailed review of the Rheims meeting. Ills. 6500 w. Tech Mod—Sept., 1909. No. 8614 D.

The Paris Aviation Exhibition. Illustrations and descriptions of the machines shown. 4000 w. Engng—Oct. 1, 1909. Serial. 1st part. No. 8493 A.

Aeronautical Motors in Paris. Illustrations, with descriptions, of motors shown at the exhibition. 1800 w. Engr, Lond—Oct. 1, 1909. No. 8496 A.

Brick Presses.

A Large Automatic Brick Press. Harry E. Atkins. Illustrated description. 800 w. Am Mach—Vol. 32. No. 42. No. 8804.

Kneading Machines.

Comparative Investigations of Mechanical Kneading (Expériences comparatives de Pétrissage mécanique et de Pétrissage à Bras). G. Coupan. Describes various kneading machines and discusses their operation and efficiency. Ills. Serial. 1st part. 6400 w. Génie Civil—Sept. 18, 1909. No. 8632 D.

Women Inventors.

Women Inventors and Discoverers. James Johnson. Brief review of some of woman's contributions to applied science. 2000 w. Cassier's Mag—Oct., 1909. No. 8465 B.

MINING AND METALLURGY.

COAL AND COKE.

Accidents.

Electrical Accidents in Mines. Reviews the casualties from this source in British mines, during the period that the present government regulations have been in force. 1800 w. Col Guard—Sept. 24, 1909. No. 8356 A.

Coal Cutting.

The Chain Electric Coal-Cutting Machine. Sidney F. Walker. An illustrated description of machines used in longwall working. 2000 w. Mech Wld—Oct. 15, 1909. No. 8889 A.

Coking Plants.

The Mexican Coke Industry. R. D. Martin. Illustrates and describes types of ovens and methods of utilizing the waste heat under boilers. 3000 w. Mines & Min—Oct., 1909. No. 8253 C.

See also Pyrometry, under MINING AND METALLURGY, COAL AND COKE.

Electric Power.

Electricity in the Coal Mining Industry. Abstract of a paper by F. C. Albrecht, before the W. Va. Coal Min. Inst. On the applications made and advantages, methods, etc. 2000 w. Elec Rev, N Y—Oct. 2, 1909. No. 8308.

See also Accidents, under COAL AND COKE.

Explosions.

Mine Gases and Colliery Explosions. H. B. Winstanley. Read before the Nat. Assn. of Col. Mgrs. A record of available information relating to mine gases. 10000 w. Ir & Coal Trds Rev—Oct. 8, 1909. No. 8959 A.

Great Britain.

Geological Research in the Coalfields. Reviews recent work in Great Britain, as reported in the *Summary of Progress* of the Geological survey. 2200 w. Col Guard—Sept. 24, 1909. Serial. 1st part. No. 8359 A.

We supply copies of these articles. See page 487.

Wages, Profits, and Royalties in the Coal Trade. An estimate of the average wages, profits, and royalties per ton of coal raised in Great Britain. 1500 w. Engr, Lond—Oct. 1, 1909. No. 8495 A.

Mexico.

The Coal Industry in Mexico. Edwin Ludlow. Read at session of the Int. Geol. Cong. Important coalfields have been discovered and are being so developed that Mexico will soon be independent of all foreign fuel supplies. Map. 3500 w. Eng & Min Jour—Oct. 2, 1909. No. 8272.

The Carboniferous Deposits of Northern Coahuila. J. G. Aguilera. Describes the geology of an important coal field in Mexico. 3500 w. Eng & Min Jour—Oct. 9, 1909. No. 8429.

See also Coking Plants, under COAL AND COKE.

Mine Conveyors.

A New Underground Conveyor. Illustrates and describes the Bothwell conveyor, which has been in use several months with satisfactory results. It is patented by Richard McPhee. 2500 w. Col Guard—Sept. 24, 1909. No. 8357 A.

Mine Dust.

British Coal Dust Experiments. Illustrated description of recent experiments with coal dust and stone dust at the Altofts Experimental Gallery. 2500 w. Ir & Coal Trds Rev—Oct. 1, 1909. No. 8956 A.

Experiments With Coal Dust at the Rossitz Experimental Gallery. Czaplinski and Jicinsky, in *Oes. Zeit. für Berg- und Hüttenwesen.* Describes experiments made to ascertain the conditions under which coal-dust can explode, and to test means of preventing coal-dust explosions. Ills. 2000 w. Col Guard—Sept. 24, 1909. Serial. 1st part. No. 8358 A.

Mine Gas.

The Detection of Firedamp. Describes a proposed method adaptable to ordinary miners' lamps. Ills. 2000 w. Col Guard—Oct. 15, 1909. No. 8890 A.

Examining for Firedamp. James Ashworth. Reviews reports from a Blue Book recently issued in England concerning the composition of blackdamp, height of testing flame, and the percentage of firedamp that is dangerous. 5000 w. Mines and Min—Oct., 1909. No. 8259 C.

Mining.

Practice of Coal Mining in Great Britain. Floyd W. Parsons. Describes methods in common use and shows the advantages of the longwall system. Ills. 3000 w. Eng & Min Jour—Oct. 23, 1909. No. 8723.

Pillar Drawing. Jonathan Jenkins. Read before the superintendents and mine foremen of the Consolidated Coal Co., of Frostburg, Md. Detailed description of the work. 3000 w. Mines & Min—Oct., 1909. No. 8258 C.

Peru.

The Coal of La Libertad, Cajamarca and Ancachs, Peru. Ernesto du Bois Lukis. Abstract translation, describing these coal deposits. 1000 w. Min Jour—Oct. 2, 1909. No. 8475 A.

Rhode Island.

Rhode Island Coal for New England? Describes deposits of hard, graphitic coal that is practically incombustible in its natural state, but is said to burn readily after chemical treatment. Ills. 2500 w. Power—Oct. 5, 1909. No. 8321.

Screening.

Plant of the Utah Fuel Co. A. C. Watts. Illustrated description of methods and machinery employed for crushing and screening coal at Sunnyside, Utah. 2200 w. Mines & Min—Oct., 1909. No. 8261 C.

Texas.

Lignite and Its Relation to Other Fuels of the Southwest. A. C. Scott. Describes the extensive deposits of lignite in Texas, and also semi-bituminous fuels and crude ore deposits of the same state, comparing the relative heating power of the three classes of fuels. 3000 w. Elec Wld—Oct. 21, 1909. No. 8809.

West Virginia.

Coal Fields of Central West Virginia. H. H. Stoek. Gives the history and geology of the region, the seams mined, methods of working, development, etc. Maps and Ills. 4000 w. Mines & Min—Oct., 1909. No. 8263 C.

COPPER.

Blast Furnaces.

A Hot-Blast Furnace for the Small Operator. Percy Andrus Babb. Illustrated detailed description of the New Model hot-blast furnace and its working. 2500 w. Eng & Min Jour—Oct. 2, 1909. No. 8267.

New Copper Blast Furnaces at Teziutlan Smeltery. Cyrus Robinson. Drawings and description of construction in which no brickwork is used. Each furnace is charged mechanically at five points. 500 w. Eng & Min Jour—Oct. 2, 1909. No. 8269.

Blast Furnace Practice in High Altitudes. R. R. Lloyd. Deals with the construction of blast furnaces in high altitudes, and the modification of general practice to suit the conditions. 1800 w. Cal Jour of Tech—Oct., 1909. No. 8761.

Chile.

Conditions and Costs of Mining at the Braden Copper Mines, Chile. William Braden. An explanation of the general conditions, operating costs, etc. 1000 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8742 F.

Converters.

Modern Type of the Barrel Copper Converters. Charles F. Shelby. Illustrated description of the design. 1000 w. Eng & Min Jour—Oct. 23, 1909. No. 8725.

We supply copies of these articles. See page 487.

Mexico.

Mines and Works of the Rio Tinto Copper Co. H. J. Baron. Illustrated description of this mining plant at Terrazas, Mexico, showing what is accomplished by American methods, and the profitable operation of the small copper smelter—3500 w. Min Wld—Oct. 2, 1909. No. 8310.

Smelters.

Small Smelting Plants in Mexico. R. W. Perry. Describes some of the small copper and lead smelting plants in successful operation. 2000 w. Eng & Min Jour—Oct. 2, 1909. No. 8271.

Smelting.

Notes on Copper Smelting in the West. Edward Dyer Peters. Remarks on the complete change in regard to the relative position of the blast furnace and reverbatory smelting furnaces, and other features of practice. 1800 w. Eng & Min Jour—Oct. 9, 1909. No. 8430.

Utah.

Moving a Mountain in Utah. Description of mining and transportation methods used to deal with ores excavated at Bingham Cañon, Utah. Ills. 1700 w. Sci Am—Oct. 16, 1909. No. 8581.

GOLD AND SILVER.

Amalgamation.

Gold Recovery by Electrolytic Amalgamation. J. H. Jory. Compares the method with the cyanide process. Ills. 1800 w. Min Wld—Oct. 2, 1909. No. 8311.

Assaying.

Assay of Cyanide Precipitate. Frank A. Bird. Describes methods of assaying the precipitate as carried out in the Salt Lake district. 1200 w. Min & Sci Pr—Oct. 9, 1909. No. 8737.

Australia.

The Deep Leads of Victoria, Australia. Stanley Hunter. Descriptive account giving cost of deep lead mining and explaining methods used. 5000 w. Min Jour—Oct. 16, 1909. No. 8876 A.

The Black Range District of Western Australia. J. Bowie Wilson. An illustrated account of a new goldfield which has developed quite rapidly and promises to become important. 2500 w. Eng & Min Jour—Oct. 9, 1909. No. 8424.

California.

Gold Mining at Grass Valley, California. Al. H. Martin. Reviews the history and illustrates and describes some of the workings. 2000 w. Min Wld—Oct. 23, 1909. No. 8715.

Cyaniding.

Oxidation and Cyanidation. Hubert A. Megraw. Discusses the oxidizing of cyanide solutions. 1500 w. Eng & Min Jour—Oct. 2, 1909. No. 8266.

The Continuous Collection of Sand for Cyaniding. W. A. Caldecott. Illustrates and describes a sand filter plant with belt transfer of sand to vat from filter table, erected in South Africa. 4000 w. Jour Chem, Met, & Min Soc of S Africa—Aug., 1909. No. 8827 E.

Cyaniding Concentrate at Taracol, Korea. J. D. Hubbard. Describes the plant and method of operating. 2500 w. Min & Sci Pr—Oct. 2, 1909. No. 8411.

See also Slimes Treatment, under ORE DRESSING AND CONCENTRATION.

Dredging.

Gold Dredging in Alaska. George E. Walsh. An account of gold dredging in Australia, California, and Alaska, showing its success in the latter. 1200 w. Sci Am—Oct. 23, 1909. No. 8586.

See also Siberia, under GOLD AND SILVER.

Georgia.

Notes on the Neglected Gold Fields of Georgia. Craig R. Arnold. An account of what has been done, and present conditions, urging systematic work. Ills. 2000 w. Min Wld—Oct. 16, 1909. No. 8713.

Hydraulic Mining.

The Ruble Hydraulic Elevator. J. McD. Porter. Illustrated detailed description of this appliance and its work. 1200 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8744 F.

Madagascar.

The Andavakoer Gold Mines, Madagascar. An account of these mines where gold is extracted from the quartz by pounding it with stones. 1400 w. Min Jour—Oct. 9, 1909. No. 8875 A.

Mexico.

Recent Mining Developments in Chihuahua. A. P. Rogers. A report of conditions that are encouraging. 2000 w. Eng & Min Jour—Oct. 2, 1909. No. 8275.

Geologic Study of the Sierra of Guanajuato. Map and illustration with description of the geology of the region, its minerals, metalliferous deposits, etc. 4000 w. Eng & Min Jour—Oct. 2, 1909. No. 8274.

Operations of Guanajuato Development Co. Illustrates and describes mines of this company where cyaniding of concentrates is being tried with a view to eliminating smelting changes as the fall in silver reduced the revenue. 3500 w. Eng & Min Jour—Oct. 2, 1909. No. 8268.

The Totolapam Mining District, Oaxaca, Mexico. Paul Wooton. Illustrates and describes the silver mines. 1400 w. Min Wld—Oct. 9, 1909. No. 8459.

San José de Gracia, a Great Mexican Gold Camp. E. A. H. Tays. Illustrated description of a mine having a record of 90 years continuous production. 4000 w. Eng & Min Jour—Oct. 2, 1909. No. 8265.

New Mexico.

Genesis of the Lake Valley, New Mexico, Silver-Deposits. Discussion of the paper of Charles R. Keys. 1000 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8747 F.

We supply copies of these articles. See page 487.

Nova Scotia.

See Antimony, under MINOR MINERALS.

Quebec.

Riviere Du Loup Goldfields—Townships of Jersey and Liniere, Beauce County, Quebec. Notes and extracts from a report by Dr. Henry Youle Hind, published in 1864. 1200 w. Can Min Jour—Oct. 15, 1909. Serial. 1st part. No. 8797.

Siberia.

Gold Dredging in Siberia. J. B. Landfield. Discusses some of the reasons why these placers have not proved profitable. Ills. 2000 w. Min & Sci Pr—Sept. 25, 1909. No. 8226.

Texas.

The Presidio Silver Mines, Shafter, Texas. Morris P. Kirk. Illustrated article giving the situation and history of the mine, occurrence and nature of the ore and the mining operations. 1200 w. Eng & Min Jour—Oct. 23, 1909. No. 8726.

IRON AND STEEL.

Bessemer Process.

Thirty Years of the Basic Bessemer Process in Germany (30 Jahre Thomasverfahren in Deutschland). A historical review. Ills. 17000 w. Stahl u Eisen—Sept. 22, 1909. No. 8655 D.

Blast-Furnace Operation.

The Limit of Fuel-Economy in the Iron Blast-Furnace. N. M. Langdon. A study of the operation, under various conditions, of a number of furnaces. 7000 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8745 F.

Heating Value of the Fuel in Shaft Furnaces and Especially in the Iron Blast Furnace (Der Wärmewert des Brennstoffes im Schachtofen und insbesonders im Eisenhochofen). Josef v. Ehrenwerth. A theoretical discussion of the fuel economy of the blast furnace. Serial. 1st part. 2200 w. Oest Zeitschr f Berg u Hüttenwesen—Sept. 18, 1909. No. 8660 D.

Blast Furnaces.

The Lubeck Blast Furnaces (Les hauts Fourneaux de Lubeck). Illustrated description of the two furnaces at this German iron works. 2000 w. Génie Civil—Sept. 25, 1909. No. 8633 D.

Copper-Clad Steel.

Copper-Clad Steel. Wirt Tassin. Describes a process by which steel is covered with a copper coat of any desired thickness, describing the product and its uses. 1600 w. Eng & Min Jour—Oct. 23, 1909. No. 8724.

Dry-Air Blast.

I. Moisture in Blast. Greville Jones. A report of experiments carried out at Clarence Iron Works, 1909. II. The Fuel Economy of Dry Blast. R. S. Moore. As indicated by calculations from empirical data. Two papers read before the Iron & Steel Inst. 2000 w. Engng—Oct. 1, 1909. No. 8494 A.

A Study of the Gayley Dry-Air Blast (Nachstudie zur Gayleyschen Windtrocknung). M. Drees. A discussion of the practical advantage of the dry blast. Serial. 1st part. 3500 w. Stahl u Eisen—Sept. 15, 1909. No. 8654 D.

Electrometallurgy.

Electric Production of Pig Iron. Illustrated description of the electric blast-furnace in use at Domnarfvet, Sweden. 700 w. Engng—Sept. 24, 1909. No. 8363 A.

Electric Smelting in Production of Iron and Steel. E. J. Ljungberg. Read before the Ir. & St. Inst. Brief account of present practice, the furnaces used, etc., describing a furnace similar to a common blast-furnace, but with three electrodes supplied with three-phase alternating current. 1000 w. Elec Engr, Lond—Oct. 1, 1909. No. 8478 A.

The Kjellin and Röchling-Rodenhauser Electric Furnaces. Dr. F. A. Kjellin. Describes the construction and advantages of the Kjellin furnace, giving cost of production of steel; and explains the working of the Röchling-Rodenhauser furnace, and cost of production. Ills. 2000 w. Elect'n, Lond—Oct. 8, 1909. No. 8867 A.

Industrial Development.

Iron and Steel. F. W. Harboard. Read before the Soc. of Chem. Ind. Considers their relation to other industries and the causes that have assisted their vast development. 4500 w. Sci Am Sup—Oct. 23, 1909. Serial. 1st part. No. 8587.

Industry.

Some Tendencies in the Iron Industry. John Jermain Porter. A study of the future based on the signs of the times. 4000 w. Mfrs' Rec—Oct. 7, 1909. No. 8383.

Ingots.

Apparatus for the Continuous Production of Steel Ingots. Illustrates and describes the apparatus designed by M. Doupeur. 1000 w. Mech Engr—Sept. 24, 1909. No. 8352 A.

Lapland.

The Iron Ore Deposits of Swedish Lapland. Information taken largely from a description by P. Nicou, in the *Ann. des Mines*. 1500 w. Ir Age—Oct. 7, 1909. No. 8376.

Iron-Ore Deposits of Swedish Lapland (Die Eisenerzlagerstätten des schwedischen Lapplandes). A statistical review. 4000 w. Stahl u Eisen—Sept. 1, 1909. No. 8651 D.

Maryland.

The Iron Ores of Maryland. Joseph T. Singewald, Jr. Description of occurrence and composition of iron ores as determined by studies of Maryland Geological Survey. 3500 w. Ec Geol—Sept.-Oct., 1909. No. 8570 D.

Newfoundland.

Mining Iron Ore at Wabana, Newfoundland. B. S. Stephenson. Illustrated description of the workings of the Nova

We supply copies of these articles. See page 487.

Scotia Steel & Coal Co., and the mining operations under the sea. 3500 w. Ir Trd Rev—Oct. 14, 1909. No. 8567.

New York.

The Great Adirondack Iron Ore Deposit. Gives a review of the interesting history of the largest known deposit outside of the Great Lake ranges. Maps and Ills. 13000 w. Ir Age—Oct. 14, 1909. No. 8544.

Open Hearth.

A New Martin Furnace with Double Hearth. Abstract of an article by Carl Brisker in *Stahl und Eisen*. Illustrated description. 800 w. Eng & Min Jour—Oct. 9, 1909. No. 8428.

Pennsylvania.

Equipment and Ore Handling at Cornwall Mine. Quincy Bent. Illustrated description of a mine in Lebanon Co., Penn., where the ore is mined by steam shovels, crushed in pit, handled in 50-ton cars, etc. 1200 w. Eng & Min Jour—Oct. 9, 1909. No. 8426.

Rolling Mills.

The Works of the Indiana Steel Co. Illustrated description of the continuous billet mill recently put in operation at Gary. 2500 w. Ir Trd Rev—Oct. 2, 1909. No. 8731.

The New 152-Inch Mill of the Otis Steel Co. The latest development in large rolling mills for heavy plate is illustrated and described. 1600 w. Ir Trd Rev—Oct. 21, 1909. No. 8732.

The Determination of the Economy of Reversing Rolling Mills. C. A. Ablett. Abstract of a paper before the Ir. & St. Inst. A criticism of some of the tests made to determine the economy. 1200 w. Elect'n, Lond—Oct. 1, 1909. No. 8487 A.

Determination of the Size of Motors for Finishing Rolls (Bestimmung der Grösse von Motoren zum Antrieb von Fein und Stabwalzwerken). Gives curves and other data on which determinations may be made. Ills. 1800 w. Stahl u Eisen—Sept. 15, 1909. No. 8653 D.

Segregation.

The Influence of Ingot-Size on the Degree of Segregation in Steel Ingots. Henry M. Howe. A brief illustrated study of segregation. 400 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8743 F.

LEAD AND ZINC.

Lead Smelting.

See Smelters, under COPPER.

Mexico.

Reminiscences of Mining in Durango. Walter D. Beverly. Describes early conditions and the improvements in railroad facilities, and in the establishment of law and order; describing the smelting practice. Ills. 3500 w. Eng & Min Jour—Oct. 2, 1909. No. 8264.

Zinc Smelting.

Progress in the Electro-Metallurgy of Zinc and Cadmium (Neuerungen in der Elektrometallurgie des Zinks und des Kadmiums). Franz Peters. Refers to both electro-thermic and electrolytic processes. Ills. 7200 w. Glückauf—Sept. 25, 1909. No. 8666 D.

MINOR MINERALS.

Antimony.

The Auriferous Antimony Ore of West Gore, Nova Scotia. D. F. Haley. Describes the geological conditions, development, and ore treatment. Ills. 2200 w. Eng & Min Jour—Oct. 9, 1909. No. 8425.

Asbestos.

The Chrysotile Asbestos Formation at Marble Bar, Western Australia. C. W. Marsh. Describes the more notable features of the occurrence, and discusses working costs. 3000 w. Min Jour—Sept. 25, 1909. No. 8348 A.

Borax.

American Borax Deposits. Charles R. Keyes. Deals with the deposits and methods of mining, and the supply. 1700 w. Eng & Min Jour—Oct. 23, 1909. No. 8730.

Borax-Deposits of the United States. Charles R. Keyes. An account of the geology of the borax deposits in the Death valley, the Mojave desert, and the Santa Clara valley. Ills. 10800 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8741 F.

Boron.

Boron. E. B. Wilson. Information concerning the minerals in which it occurs; tests and methods of analysis; its uses, etc. 3500 w. Mines & Min—Oct., 1909. No. 8262 C.

Chromite.

Chrome Ore in Canada. Phillips Thompson. Information concerning these deposits, taken from a recent report by Fritz Cirkel. 800 w. Eng & Min Jour—Oct. 9, 1909. No. 8427.

Diamonds.

The Arkansas Diamond Fields. Austin Q. Millar. Brief description of the geologic conditions of the diamond-bearing fields. 1000 w. Min & Sci Pr—Oct. 16, 1909. No. 8739.

Graphite.

The Flake Graphite Industry in the United States. Frederick D. Chester. Considers the commercial features of the industry. 900 w. Eng & Min Jour—Oct. 16, 1909. No. 8722.

See also same title, under ORE DRESSING AND CONCENTRATION.

Manganese.

Sources and Uses of Manganese in United States. E. C. Harder. Abstracted from Mineral Resources of U. S. Information concerning the ores that yield manganese, the location of the deposits, and some of the uses. 2000 w. Min Wld—Oct. 23, 1909. No. 8716.

We supply copies of these articles. See page 487.

Mercury.

Dulces Nombres Quicksilver Deposit, Mexico. Percy Andrus Babb. Describes the interesting geology of these deposits, giving a theory of the ore deposition. Ills. 2800 w. Eng & Min Jour—Oct. 2, 1909. No. 8276.

Natural Gas.

The Anticlinal and Hydraulic Theories of Oil and Gas Accumulation. Malcolm J. Munn. Discusses practical application of these theories and the advantages of the latter in prospecting for new pools of oil and gas. Also discussion of above by F. G. Clapp. 6500 w. Ec Geol—Sept.-Oct., 1909. No. 8569 D.

Oil.

Notes from the Oil Fields. Frank W. Brady. Brief account of development in the Brooke County, W. Va., and Steubenville, Ohio, fields. Ills. 2000 w. Mines & Min—Oct., 1909. No. 8260 C.

See also Natural Gas, under MINOR MINERALS; and Texas, under COAL AND COKE.

Salt.

Salt (Das Salz). A review of salt mining and production in all parts of the world. 7200 w. Glückauf—Sept. 18, 1909. No. 8665 D.

Tellurium.

Some Observations on the Tellurides. Victor Lehner. Describes occurrence of tellurium and various laboratory experiments with tellurides. 7000 w. Ec Geol—Sept.-Oct., 1909. No. 8571 D.

Tin.

The Assay of Tin Ore. L. Parry. A criticism of methods in common use, with a review of methods proposed and used, and a description of the gas reduction assay which is said to be the most accurate. 5000 w. Min Jour—Sept. 25, 1909. No. 8350 A.

Tin Mining in Bolivia (Unterlagen zu einer bergmännischen Lagerstättenbegutachtung im bolivianischen Zinnerzbezirk). Herr Everding. A general review of conditions, practice, etc. 8000 w. Glückauf—Sept. 11, 1909. No. 8663 D.

Uranium.

See Vanadium, under MINOR MINERALS.

Vanadium.

Vanadium: Occurrence and Uses. Henry E. Ede. Brief note on the discovery of this element, discussing the vanadium ores, and the uses of the metal. 1500 w. Min Jour—Sept. 25, 1909. No. 8349 A.

Uranium and Vanadium Metallury. Justin H. Haynes. History and description of the process used to separate the minerals from their ores. 2500 w. Mines & Min—Oct., 1909. No. 8255 C.

Vanadium-Deposits in Peru. Discussion of the paper of D. Foster Hewett. 800 w. Bul Am Inst of Min Engrs—Oct., 1909. No. 8746 F.

MINING.

Development.

The Development of a Mine. Discusses points to be observed in development of a mine of payable ore. 3300 w. Aust Min Stand—Sept. 1, 1909. No. 8825.

Dry Houses.

Examples of Modern Sanitary Dry Houses. Albert H. Fay. Illustrates and describes the change houses used by the Oliver Iron Mining Co. 1200 w. Eng & Min Jour—Oct. 23, 1909. No. 8728.

Electric Hoisting.

Electric Winding at the Ferndale Collieries. Illustrated description of the winding machinery installed. 2500 w. Ir & Coal Trds Rev—Oct. 15, 1909. No. 8960 A.

Electric Power.

Notes on Electric Practice in Mines. W. O. Pepper. Considers briefly the power house, cables, switchboards, transformers, coal cutters, winding, &c. 2000 w. Elec Rev, Lond—Oct. 8, 1909. No. 8863 A.

Electrical Power at Mexican Mines and Mills. Charles V. Allen. Illustrated descriptions of a number of installations. 1500 w. Eng & Min Jour—Oct. 2, 1909. No. 8278.

See also Quarrying, under MINING.

Head Frames.

Design and Construction of Head Frames (Calcul et Construction des Cages d'Extraction). N. Dessart. Discusses a number of types. Ills. 10000 w. All Indus—Sept., 1909. No. 8620 D.

Hoisting.

Automatic Cage Tub Stops. Illustrates and describes the "Winter" tub stop. 1500 w. Ir & Coal Trds Rev—Oct. 15, 1909. No. 8961 A.

Friction Drums and Brakes. Warren O. Rogers. Illustrates and describes types of these devices as used in hoisting-engine practice, showing how they are constructed and applied. 1500 w. Power—Oct. 26, 1909. No. 8772.

Hoisting Engines.

Test of a Steam Hoisting Engine and an Exhaust-Steam Turbo-Generator in Connection with It (Untersuchung einer Dampffördermaschine sowie einer damit verbundenen Abdampf-Turbogeneratorenanlage auf Zeche Prosper II). Ills. 1800 w. Glückauf—Sept. 25, 1909. No. 8667 D.

Hoisting Ropes.

Notes on Corrosion, with Special Reference to the Corrosion of Steel Winding Ropes. M. Thornton Murray. Gives a summary of theories of corrosion at present in vogue and especially considers the corrosion of winding ropes. Ills. 4500 w. Jour Chem, Met & Min Soc of S Africa—Aug., 1909. No. 8828 E.

Labor.

See Mexico, under MISCELLANY.

We supply copies of these articles. See page 487.

Mine Inspection.

Mine Inspection. Courtenay De Kalb. Address presented at the Am. Min. Cong. Considers it should be solely that of police regulation with the object of preserving health and property. 2000 w. Min & Sci Pr—Oct. 9, 1909. No. 8734.

Inspection of Mines. J. A. Holmes. Address presented at Am. Min. Cong. Considers it should be a function of the State for the purpose of proper execution of mining laws. 1000 w. Min & Sci Pr —Oct. 9, 1909. No. 8735.

Mine Lighting.

Importance of Acetylene in Mine Operations. Robert Grimshaw. Abstract translation of paper by Herr R. Penkert, in *Kohle und Erz.* Ills. 2500 w. Min Wld —Oct. 16, 1909. No. 8711.

Mine Valuation.

Development Sampling and Ore Valuation of Gold Mines. C. Baring Horwood and Mungo Park. Calls attention to essential features of good practice in sampling and mine valuation. 3000 w. Min Jour—Sept. 25, 1909. No. 8351 A.

Ore Handling.

Ore Handling at Copper Queen Mine. Maxwell C. Milton. Illustrates and describes the arrangements for handling sticky ore. 2500 w. Mines & Min—Oct., 1909. No. 8257 C.

Patenting.

Patenting Mineral Land. George A. Packard. Details of the process of obtaining a patent to the property of the Osseo Mining Co. 2500 w. Min & Sci Pr—Oct. 16, 1909. No. 8738.

Quarrying.

An Electrically Equipped Stone Quarry. Illustrates and describes a quarry near Gary, Ill., and its equipment. 2500 w. Elec Rev, N Y—Oct. 16, 1909. No. 8780.

An Electrically-Operated Quarry and Plant for Production of Broken Stone at Gary, Ill. Full illustrated detailed description of the plant and its equipment. 7500 w. Eng News—Oct. 21, 1909. No. 8817.

Record Systems.

Keeping Engineering Records. E. E. Whiteley. Explains methods used by Calumet and Arizona Mining Co., and Superior and Pittsburg Copper Co., at Bisbee, Ariz. 2500 w. Mines & Min—Oct., 1909. No. 8254 C.

Timbering.

Applications of Concrete in the Metal-Mining Industry. Henry W. Edwards. Describes recent uses of reinforced-concrete underground and in surface plant and equipment. 3000 w. Engineering Magazine—Nov., 1909. No. 8830 B.

The Application of Steel to Mine Timbering. R. B. Woodworth. Abstract of paper read before the Am. Min. Cong. Reviews the use of steel in mines, describing the forms used, and the advantages as compared with wood. Ills. 5000 w. Min Wld—Oct. 2, 1909. No. 8312.

Welfare Work.

Welfare Work in Iron Mining. W. H. Moulton. Read before L. Superior Min. Inst. Explains the methods of the Cleveland-Cliffs, Colorado Fuel & Iron, and other companies. 5000 w. Ir Age—Oct. 14, 1909. No. 8546.

ORE DRESSING AND CONCENTRATION.

Graphite.

Concentration of Flake Graphite. Frederick D. Chester. Discusses the concentration of the ore, and the conditions that determine profitable production. 1000 w. Eng & Min Jour—Oct. 23, 1909. No. 8729.

Lead Milling.

The Daly-West Concentrating Plants, Utah. Leroy A. Palmer. Illustrated description of a mill said to be a model lead-silver concentrator. 2200 w. Min Wld—Oct. 9, 1909. No. 8458.

Mixed Sulphides.

The Concentration and Separation of Mixed Sulphides at Rosas, Sardinia (Die Aufbereitung von Mischerzen in Rosas, Insel Sardinien). Umberto Cappa. Describes the process and gives a flow sheet of the mill. Ills. 2000 w. Serial. 2 parts. Oest Zeitschr f Berg u Hüttenwesen—Sept. 18 and 25, 1909. No. 8661 each D.

Ore Dressing.

Ore Dressing in the United States and Mexico. H. A. Guess. Abstract of a paper read before the Colo. Sci. Soc. An outline of the principal processes other than smelting. 6000 w. Min Wld—Oct. 16, 1909. No. 8712.

Sampling.

The Projected Custom Sampling Plant —To Be Erected This Year in Cobalt, Ont. Explains the province of the sampling company, and shows the layout and process of the proposed works. 1500 w. Can Min Jour—Oct. 1, 1909. No. 8372.

Slime Treatment.

A Proposed New System for the Cyanide Treatment of Slimes. Ferdinand McCann. An explanation of the dilution system of slime treatment. 2500 w. Eng & Min Jour—Oct. 2, 1909. No. 8277.

MISCELLANY.

Alloys.

The Alloys of Silicon, Tin and Zinc (Les Alliages de Silicium). M. A. Portevin. Summarizes the results of Prof. Tammann's researches on alloys of silicon with aluminium, bismuth, calcium, cobalt, magnesium, lead, tin and thallium; of tin with calcium, cobalt, chromium, potassium, sodium and platinum; and of zinc with various metals. Ills. 8000 w. Rev de Métal—Sept., 1909. No. 8607 E + F.

We supply copies of these articles. See page 487.

Applied Chemistry.

The International Chemical Congress. John B. C. Kershaw. A short resumé of papers of special interest. 3000 w. Cassier's Mag—Oct., 1909. No. 8467 B.

Idle Claims.

Paralysis of Mining Districts. Edmund B. Kirby. Address before the Am. Min. Cong. Discusses the loss from idle claim-owners, and the remedy. 3500 w. Min & Sci Pr—Oct. 2, 1909. No. 8410.

The Paralysis of Mining Districts and a Remedy. Edmund B. Kirby. Read before the Am. Min. Cong. Urges the increase of taxation until every claim must be worked or opened to prospectors. 2500 w. Min Wld—Oct. 16, 1909. No. 8714.

Land Classification.

The Mining Man's Interest in Land Classification. George Otis Smith. Address before the Am. Min. Cong. Explains the advantages of this work carried out by the Geological Survey. 2000 w. Min & Sci Pr—Oct. 9, 1909. No. 8736.

Mexico.

Changing Conditions in Mexico. H. A. Megraw. Brief account of the changes in labor conditions. 1500 w. Eng & Min Jour—Oct. 2, 1909. No. 8270.

RAILWAY ENGINEERING.

CONDUCTING TRANSPORTATION.

Signaling.

Report on Signaling Practice. Report of Committee presented at recent meeting of the Ry. Sig. Assn. at Louisville, Ky. Ills. 1700 w. R R Age Gaz—Oct. 15, 1909. Serial, 1st part. No. 8812.

Significance of Speed Signaling. George S. Hodgins. An explanation of proposed changes and their significance. 1400 w. Ry & Loc Engng—Oct., 1909. No. 8298 C.

A New Automatic Electric Signalling System for Railroads. Description of method used on The Great Western Railroad, England. Ills. 1200 w. Sci Am—Oct. 16, 1909. No. 8582.

New Signals at Providence. Describes the changes in track layout, and interesting features of the signal system. Ills. 2200 w. R R Age Gaz—Oct. 8, 1909. No. 8449.

"M. D. M." Auto-Combiner for the Hydraulic Control and Interlocking of Points and Signals at Cabin 11 of the Paris-Nord Railway, at Landy (Application de l'Auto-Combinateur "M. D. M." pour la Commande par Fluide et l'Enclenchement des Aiguilles et des Signaux à la Cabine No. 11 de Paris-Nord, Garage du Landy). Albert Moutier. Illustrated description. 11500 w. Rev Gen des Chemins de Fer—Sept., 1909. No. 8612 G.

Surprise Tests.

Surprise and Efficiency Tests of Those Charged with the Operation of Trains. Frederick C. Syze. Gives statistics relating to loss of life and injuries on the railways of the United States, and discusses tests made to detect lax practice among employees. Discussion. 14000 w. Pro N Y R R Club—Sept. 17, 1909. No. 8522.

Train Loads.

The Adjusted Tonnage Formula for Determining Train Loads. Alexander P. Gest. An explanation of this method of determining proper train loads. 900 w. R R Age Gaz—Oct. 22, 1909. No. 8815.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Inspecting the H-6 Brake. Remarks to serve as a guide to an inspector. Ills. 2500 w. Ry & Loc Engng—Oct., 1909. No. 8300 C.

Tests of Continuous Automatic Brakes on Goods Trains (Versuche mit durchgehenden selbsttätigen Bremsen bei Güterzügen). Johann Rihosek. A review of the tests on the Austrian State Railways. Ills. Serial. 1st part. 3600 w. Zeitschr d Oest Ing u Arch Ver—Sept. 24, 1909. No. 8691 D.

Car Lighting.

An Oil-Gas Generating Plant (Oelgasanstalt mit Generatorbetrieb). Fritz Landsberg. Describes oil-gas generation, transmission, and utilization for car lighting on the Berlin Ringbahn. Ills. 4000 w. Zeitschr d Ver Deutscher Ing—Sept. 11, 1909. No. 8913 D.

Compressed Air.

Improvement of Compressed-Air Traction by the Utilization of the Heat Generated in Compressing the Air (Amélioration de la Traction à Air comprimé par l'Utilisation de la Chaleur de Compression de l'Air). L. Pierre-Guédon. Suggests means of improving the efficiency of compressed-air traction. Ills. 6000 w. Génie Civil—Sept. 11, 1909. No. 8631 D.

Electrification.

A Proposal to Force the Railways Entering Chicago to Adopt Electricity. Editorial on the unreasonableness of the demand. 1000 w. Eng News—Oct. 7, 1909. No. 8407.

Freight Cars.

Fifty-Ton Steel Gondola Car. Illustrated detailed description of a car for the Virginian railway. 500 w. Am Engr & R R Jour—Oct., 1909. No. 8303 C.

Locomotive Boilers.

The Modern Locomotive Boiler. John W. Hobson. Considers questions of design and construction. Plates. 9000 w.

We supply copies of these articles. See page 487.

Trans N-E Coast Inst of Engrs & Shipbldrs—Sept., 1909. No. 8502 N.

Locomotive Counterbalancing.

Locomotive Counterbalancing. H. H. Vaughan. Read before the Can. Ry. Club. A discussion of the theoretical principles underlying counterbalancing. 4500 w. Am Engr & R R Jour—Oct., 1909. No. 8304 C.

Locomotive Fireboxes.

A New Departure in Flexible Staybolts. Discussion of H. V. Wille's paper on this subject. Ills. 2500 w. Jour Am Soc of Mech Engrs—Oct., 1909. No. 8533 F.

Locomotive Fuels.

Sub-Bituminous or Liguite Coal as Fuel for Locomotives. E. W. Fitt. Describes deposits in Wyoming and Colorado, giving average analyses, and some of the objections to their use on locomotives, and a short description of front-end arrangements that are in use. Ills. 2500 w. Am Engr & R R Jour—Oct., 1909. No. 8302 C.

Formation of Coal, Combustion; Economical Methods of Handling and Firing Bituminous Coal for Locomotive Use. C. F. Smith. Also discussion. 4000 w. Pro St Louis Ry Club—Sept. 17, 1909. No. 8521.

Locomotive Performances.

Some Recent Locomotive Performances on the Northern Railway of France. J. T. Burton-Alexander. Gives results of personal observations of results obtained with 4-6-0 passenger engines. 3000 w. Engr, Lond—Oct. 8, 1909. No. 8938 A.

Locomotives.

Latter-Day Developments of the American Locomotive. H. Keith Trask. This first of two articles discusses wheel arrangements and compounding and reviews locomotive development. 4000 w. Engineering Magazine—Nov., 1909. No. 8832 B.

Western Maryland Engines. Illustrates and describes a 4-6-2 passenger, and a Mallet articulated compound for work on grades of 3 per cent. and curves of 20 degs. 1000 w. Ry & Loc Engng—Oct., 1909. No. 8297 C.

Pacific Type Locomotive with Superheater. Illustrated description of 4-6-2 engines, using high degree superheated steam at 150 lbs. pressure, built for the Great Northern Ry. 1200 w. Am Engr & R R Jour—Oct., 1909. No. 8305 C.

Pacific Type Locomotives, C. P. R. Illustrated description of engines recently built for the Canadian Pacific Ry. 1200 w. Ry & Engng Rev—Oct. 23, 1909. No. 8776.

Superheated Steam Locomotives, San Paulo (Brazilian) Railway. Illustrated description of a 2-8-0, consolidation type locomotive with 6-wheel tender. 500 w. Engr, Lond—Oct. 8, 1909. No. 8940 A.

New Types of Locomotives on the Italian Railways (I nuovi Tipi di Locomotive-Tender delle Ferrovie Italiane). Plates and description of three recent types. 2500 w. Ing Ferro—Sept. 16, 1909. No. 8644 D.

Locomotive Scales.

Locomotive Weighing Machine, with Automatic Indicating Quadrants. Illustrations of an English built machine, with brief description. 300 w. Engng—Oct 15, 1909. No. 8897 A.

Locomotive Springs.

Locomotive Springs. M. Kinkead. Abstract of paper read before the Can. R. R Club. Gives tables issued by the Am. Loc. Co., and discusses the subject generally. 2500 w. Mech Engr—Oct. 15, 1909. No. 8882 A.

Locomotive Valve Gears.

The Baker-Pilliod Valve Gear. The present number gives an illustrated description of the construction. 1200 w. Ry & Loc Engng—Oct., 1909. Serial. 1st part. No. 8299 C.

Walschaerts Valve Gear on Lackawanna Consolidation Locomotives. Illustrates and describes the general arrangements and principal details of the Walschaerts valve gear as applied to 14 locomotives. 1600 w. R R Age Gaz—Oct. 15, 1909. No. 8813.

Mail Exchange.

The Burr Automatic Pneumatic Mail Exchange. Illustrated description of a device for the exchange of mail between stations and moving trains. 900 w. R R Age Gaz—Oct. 15, 1909. No. 8814.

Passenger Cars.

New Passenger Equipment for the St. Paul. Illustrated description of the buffet library car, the construction of which is typical of all other cars recently built. 1200 w. R R Age Gaz—Oct. 1, 1909. No. 8246.

Shops.

Shop Kinks. A collection of kinks submitted in response to the competition under direction of this paper. Ills. 3000 w. R R Age Gaz—Oct. 1, 1909. No. 8245.

Car Shops of the Whipple Car Co. Illustrated detailed description of new shops in Chicago. 1200 w. Ry & Engng Rev—Oct. 23, 1909. No. 8777.

The Scranton Locomotive Shops of the Lackawanna Railroad. Plan and illustrated description of large shops providing for 36 pits. Also their equipment. An extensive subway system connects all buildings. 2500 w. Eng Rec—Oct. 16, 1909. No. 8591.

The Works of Kerr, Stuart & Co., Limited, at Stoke-on-Trent. Plate and illustrated description of works and equipment for building locomotives, and other railway materials. 2000 w. Engr, Lond—Oct. 15, 1909. No. 8946 A.

The New Locomotive Repair Shops in Schneidemühl (Die neue Lokomotiv-Reparatur Werkstätte in Schneidemühl).

We supply copies of these articles. See page 487.

G. Promnitz. Illustrated description of these extensive works in Germany. 5000 w. Glasers Ann—Sept. 1, 1909. No. 8689 D.

Train Lighting.

Electric Train Lighting on European Railroads. Extracts from a paper by Max Buttner, before the Assn. of Car Lighting Engrs., Chicago. Information in regard to the extensive use of electric light, the equipments used, &c. 3000 w. Ry & Engng Rev—Oct. 23, 1909. No. 8778.

PERMANENT WAY AND BUILDINGS.

Cable Railways.

A Cable Railway on the Island of Capri. Brief illustrated description of this recent installation. 700 w. Sci Am Sup—Oct. 16, 1909. No. 8584.

The Sacro Monte di Varese Funicular Railway (La Tramvia funicolare del Sacro Monte di Varese). Alcide Sculati. Illustrated description. 2200 w. Ing Ferro—Sept. 1, 1909. No. 8642 D.

Crossings.

See Concrete, under CIVIL ENGINEERING, BRIDGES.

Elevated Railways.

An Armored Concrete Viaduct. C. Van Langendouck. Illustrated description of an elevated railway in Rotterdam. Sci Am Sup—Oct. 23, 1909. No. 8589.

The Delaware Avenue Elevated Railway, Philadelphia. Illustrated detailed description of a steel viaduct about 4161 ft. long, built where settlement and lateral displacement were a serious consideration. 2000 w. Eng Rec—Oct. 23, 1909. No. 8705.

Rails.

Character, Distribution and Calculation of the Horizontal Stresses in Railway Tracks (Role, Répartition et Calcul des Actions horizontales dans les Voies des Chemins de Fer). M. L. Schlussel. A theoretical discussion of the stresses on the rail heads caused by transverse displacement of the wheels. Ills. 18000 w. Mem Soc Ing Civ de France—Sept., 1909. No. 8600 G.

Spikes.

Screw-Spikes in European Railroads. Notes from a paper by W. C. Cushing, quoting extracts from a letter from E. Siegler, giving details of European practice. 3000 w. Eng Rec—Oct. 9, 1909. No. 8434.

Stations.

Railway Improvements in Rotterdam (Spoorwegverbindingen te Rotterdam). A. Plate. Describes a new station, terminal improvements at Delft harbor, etc. Ills. 14000 w. De Ingenieur—Sept. 25, 1909. No. 8921 D.

Terminals.

The New Soo Line Terminal in St. Paul. Illustrated description of the terminal arrangements and construction methods. 4000 w. Eng Rec—Oct. 9, 1909. No. 8440.

Erie Railroad Terminal Improvements at Jersey City. Illustrated detailed description of the Erie portion of the subway of the Hudson tunnels, which is designed to support very heavy loads. 1500 w. Eng Rec—Oct. 16, 1909. 1800 w. Eng Rec—Oct. 16, 1909. No. 8597.

Track Maintenance.

The Cost of Permanent Way Renewals. R. Price Williams. Read before the Ir. & St. Inst. Considers the serviceable life and cost of renewals of permanent way of British railways. 3000 w. Engng—Oct. 8, 1909. No. 8895 A.

TRAFFIC.

Demurrage.

Uniform Demurrage Rules. Extracts from an address by John H. Marble before the convention of the Grain Dealers Nat. Assn. 2000 w. R R Age Gaz—Oct. 22, 1909. No. 8816.

Explosives.

Transportation of Dangerous Articles. Railway Officials' Responsibilities and Duties. Col. B. W. Dunn. On the work of the Bureau of Explosives in connection with the transportation of dangerous articles. Also discussion. 10000 w. Pro Cent Ry Club—Sept. 10, 1909. No. 8520 C.

Freight Rates.

Shall Rates in the West Be Based on Distance or on Industrial and Commercial Conditions? Editorial discussion. 2500 w. R R Age Gaz—Oct. 8, 1909. No. 8447.

MISCELLANY.

Canada.

Transport and Canadian Development. Editorial, with map, on the importance of transport facilities in the development of the country. 2000 w. Engng—Oct. 15, 1909. No. 8932 A.

French West Africa.

The Railways of French West Africa (Note sur les Chemins de Fer de l'Afrique occidentale française). R. Godfernaux. Exhaustive description of the Dakar-Saint Louis line and equipment. Ills. 7500 w. Rev Gen des Chemins de Fer—Sept., 1909. No. 8613 G.

N. Y., N. H. & H.

New York, New Haven & Hartford. Editorial review of President Mellen's last annual report. Map. 2000 w. R R Age Gaz—Oct. 8, 1909. No. 8448.

United States.

The Relation of Railways to Canals. John F. Stevens. A general outline of the conditions in the United States. 3000 w. Yale Sci M—Oct., 1909. No. 8766 C.

Western Railroad Association.

The Relations of the Western Railway Association to Railways and the Manufacturers of Railway Devices. George S. Payson. Address and discussion on railway patents. 9000 w. Pro W Ry Club—Sept. 21 1909. No. 8740 C.

We supply copies of these articles. See page 487.

STREET AND ELECTRIC RAILWAYS.

Accounting.

The Audit of the Accounts of Tramway Undertakings and Tramway Finance Companies. Outlines some of the important matters in relation to the auditor's duty, and some points that appear in tramway finance. 3000 w. Elec Rev, Lond—Sept. 24, 1909. Serial. 1st part. No. 8343 A.

Cars.

Steel Passenger Cars for the Hudson and Manhattan Railroad. Illustrated description of cars to be used in tunnels. 2000 w. Elec Ry Jour—Oct. 2, 1909. No. 8215.

See also Single Phase, and Trolley Lines, under STREET AND ELECTRIC RAILWAYS.

Car Weights.

Car Weights as Affecting Operating Costs. M. V. Ayres. (Abstract.) Theoretical discussion, considering power consumption, car repairs, track repairs, etc. 4000 w. Elec Ry Jour—Oct. 7, 1909. No. 8455.

Controllers.

Recent Developments in Railway Motor Control. Clarence Renshaw. (Abstract.) Considers improvements in unit switch control, and multiple unit operation with hand-operated controllers. Ills. 2000 w. Elec Ry Jour—Oct. 7, 1909. No. 8456.

Current Economy.

Current Consumption. R. S. Pilcher. Read before Munic. Tram. Assn. Some suggestions for the systematic supervision of motor drivers that results in current saving. 2200 w. Elec Engr, Lond—Oct. 1, 1909. No. 8477 A.

Denver.

The Denver City Tramway System. Map, and illustrated detailed description of the system, its construction, power generation, equipment, operation, etc. With plates. 10800 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8216.

Direct Current.

Traction System Using Constant Direct Current. J. E. Dalemont. An account of a proposal by M. Potterat. 1800 w. Elec Wld—Oct. 14, 1909. No. 8554.

See also Voltage, under STREET AND ELECTRIC RAILWAYS.

Electric Traction.

Rapid Transit in Cities (Stadt-Schnellbahnen). G. Brecht. Discusses the larger factors entering into the solution of traffic problems, capacity, speed, etc. Ills. Serial. 1st part. 5000 w. Glasers Ann—Sept. 15, 1909. No. 8682 D.

Freight Traffic.

Express and Freight Traffic on Interurban Lines. S. L. Vaughan. Discusses tariffs and classifications, solicitation, errors, shorts, bad orders, claims, revenue and accounting. 3500 w. Elec Ry Jour—Oct. 7, 1909. No. 8453.

Interurban.

The British Columbia Electric Railway. Describes the service, operation, power generation, substations, etc. 2500 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8220.

The Denver and Interurban 11000-Volt Railroad. Illustrated description of the electrified division of the C. & S. Ry. between Denver & Boulder, Colo., operated by 11000-volt alternating-current. 2500 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8217.

The Beebe Syndicate Interurban System in Central New York—Power Supply Equipment and Traffic Features. Illustrated description of the power supply and distribution scheme, rolling stock, etc. 2000 w. Elec Ry Jour—Oct. 16, 1909. No. 8717.

Locomotives.

Four-Speed Three-Phase Locomotive for the Simplon Tunnel. Plate and illustrated description of electric locomotives recently completed for this service. 3000 w. Engng—Oct. 1, 1909. Serial. 1st part. No. 8491 A.

Four-Speed, Three-Phase, Brown-Boveri Locomotives (Locomotives Triphasées à quatre Vitesses, Système Brown-Boveri). M. Henry. Illustrated description. 2000 w. L'Elecn—Sept. 11, 1909. No. 8619 D.

Los Angeles.

Electric Railways at Los Angeles. Map and description of the transportation features. Plates. 3500 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8224.

Operation.

Operating Features of the Sea View Railroad Company. Illustrates and describes a single-track line on the western shores of Narragansett Bay. 2500 w. Elec Ry Jour—Oct. 9, 1909. No. 8513.

Portland, Ore.

Operating Features of the Portland Railway, Light & Power Company. An illustrated article explaining shop records and methods, freight and passenger service, power improvements, etc. 6000 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8222.

Rack Railways.

The Chamonix-Montenvers Rack Railway (Le Chemin de Fer à Crémaillère de Chamonix au Montenvers). Gustave Chappuis. Illustrated description. Serial. 1st part. 2000 w. Bul Tech d l Suisse Romande—Sept. 10, 1909. No. 8622 D.

We supply copies of these articles. See page 487.

Railless.

Railless Electric Traction. Illustrated description of the railless trolley system at Hendon. 2500 w. Tram & Ry Wld—Oct. 7, 1909. No. 8871 B.

Rails.

Rail Grooves and Track Gage for Curved Tracks. C. W. L. Filkins. Discusses the determination of the minimum groove, and the rail gage-line. Diagrams. 3000 w. Elec Ry Jour—Oct. 6, 1909. No. 8452.

Salt Lake City.

Rehabilitation of the Utah Light & Railway Property. Illustrated description of the reconstruction of a line having 100 miles of track, practically all within Salt Lake City, Utah. 3000 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8218.

San Francisco.

Electric Railways of San Francisco and Its Environs. Illustrates and describes features of San Francisco and Oakland railways, their operation and equipment. 9000 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8223.

Seattle.

Railways of the Puget Sound District. Map and illustrated description of the electric railways of Seattle, which are of special interest because of the natural features and great increase in population. 7000 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8221.

Shops.

The Central Repair Depot of the London County Council Tramways. W. E. Ireland. Illustrated description of the buildings and equipment. Read before the Munic. Tram. Assn. 6500 w. Tram & Ry Wld—Oct. 7, 1909. No. 8872 B.

Central Repair Depot, L. C. C. Tramways. W. E. Ireland. Abstract of a paper read before the Munic. Tram. Assn., London. Describes the shops and equipment. Ills. 3000 w. Elec Engr, Lond—Sept. 24, 1909. No. 8338 A.

Single Phase.

Recent Improvements on the Hamburg-Blankanese-Ohlsdorf High Tension Single-Phase Railway. Illustrates and describes the mechanical features of the new cars and their operation. 2000 w. Elec Ry Jour—Oct. 23, 1909. No. 8718.

The Rotterdam - Haag - Scheveningen Railway. Illustrated detailed description of a 10000-volt, single-phase line in Holland, its construction, equipment and service. 3000 w. Elec Ry Jour—Oct. 2, 1909. No. 8214.

Spokane.

Electric Railways in and About Spokane. Illustrated descriptions of the track construction, power stations, rolling stock, shops, etc. Maps. 3000 w. Elec Ry Jour—Oct. 2, 1909. Souvenir Sec. No. 8219.

Subways.

Project for a Subway in Vienna (Projekt, betr. elektrische Untergrundbahnen durch die Innere Stadt Wien). Karl Hochenegg. Brief review of the project. Ills. Serial. 1st part. 1500 w. Elek Kraft u Bahnen—Sept. 4, 1909. No. 8904 D.

Subway Signalling.

The Signals in the New Tunnels of the Hudson & Manhattan. J. Leisenring. Illustrated detailed description of the automatic block signal system installed. 2200 w. R R Age Gaz—Oct. 8, 1909. Serial. 1st part. No. 8450.

Subway Stations.

The Stations of the Washington St. Tunnel, Boston, Mass. Laurence B. Manley. An illustrated description of the tunnel stations and their appurtenances. 4500 w. Eng News—Oct. 7, 1909. No. 8402.

Surface Contact.

The "G. B." Tramway System and Its Results in Lincoln. S. Clegg. Read before the Incor. Assn. of Munic. & Co. Engrs. An account of the working of this surface-contact system. Also discussion. 5500 w. Surveyor—Oct. 1, 1909. No. 8474 A.

Terminals.

Express Depot, Vault and Stables at Utica, N. Y. Illustrates and describes the express and freight station, a fireproof vault for storing tickets and records, and model stables. 2500 w. Elec Ry Jour—Sept. 4, 1909. No. 7544.

Track Construction.

Notes on Street-Railway Track Construction and Repair (Einiges über Gleisbau und Gleisreparaturarbeiten elektrischer Strassenbahnen). Franz Scheinig. Discusses rail laying, rail bonding, etc. Ills. 2500 w. Elek Kraft u Bahnen—Sept. 4, 1909. No. 8905 D.

Trolley Lines.

Catenary Trolley-Line Construction. George W. Cravens. Illustrates and describes single and double catenaries and their construction. 3000 w. Elec Rev, N Y—Oct. 2, 1909. No. 8307.

Some Comparisons of Continental and British Methods of Operating Tramways. A. R. Fearnley. A discussion of types of cars used, and considers the bow collector a better arrangement than the trolley boom. 2500 w. Elect'n, Lond—Sept. 24, 1909. No. 8344 A.

Trucks.

The General Principles of Modern Truck Construction. J. A. O'Brien. Studies the action of trucks on rails and the defects in present designs, and a type of construction known as non-parallel axle. 1500 w. Elec Rev, Lond—Sept. 3, 1909. No. 7729 A.

Voltage.

1200-Volt D. C. Car Equipment. F. E. Case. (Abstract.) Explains the operation and economy of 1200-volts in preference to 600-volts. 1800 w. Elec Ry Jour—Oct. 7, 1909. No. 8454.

We supply copies of these articles. See page 487.

EXPLANATORY NOTE—THE ENGINEERING INDEX

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily obtainable and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first instalment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20 cts. each or a book of twelve for $2.00; three books for $5.00.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents; thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10 cents per month, or $1.00 a year; to non-subscribers, 25 cents per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

Alliance Industrielle. *m.* Brussels.
American Architect. *w.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U. S. A.
American Machinist. *w.* New York.
Anales de la Soc. Cien. Argentina. *m.* Buenos Aires.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. Ing. d Arch Ital. *s-m.* Rome.
Applied Science. *m.* Toronto, Ont.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *w.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brass World. *m.* Bridgeport, Conn.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Bur. of Standards. *qr.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin du Lab. d'Essais. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. of Can. Min. Inst. *qr.* Montreal.
Bull. Soc. Int. d'Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bull. Int. Railway Congress. *m.* Brussels.
Bull. Scien. de l'Assn. des Elèves des Ecoles Spéc. *m.* Liége.
Bull. Tech. de la Suisse Romande. *s-m.* Lausanne.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *w.* Toronto and Montreal.
Canadian Mining Journal. *b-w.* Toronto.
Cassier's Magazine. *m.* New York and London.
Cement. *m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Clay Record. *s-m.* Chicago.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.

Comptes Rendus de l' Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Cornell Civil Engineer. *m.* Ithaca.
Deutsche Bauzeitung. *b-w.* Berlin.
Die Turbine. *s-m.* Berlin.
Domestic Engineering. *w.* Chicago.
Economic Geology. *m.* New Haven, Conn.
Electrical Age. *m.* New York.
Electrical Engineer. *m.* London.
Electrical Engineering. *w.* London.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electric Railway Journal. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Elektrische Kraftbetriebe u Bahnen. *w.* Munich.
Electrochemical and Met. Industry. *m.* N. Y.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnik u Maschinenbau. *w.* Vienna.
Elektrotechnische Rundschau. *w.* Potsdam.
Elettricità. *w.* Milan.
Engineer. *w.* London.
Engineering. *w.* London.
Engineering-Contracting. *w.* New York.
Engineering Magazine. *m.* New York and London.
Engineering and Mining Journal. *w.* New York.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of Western Penna. *m.* Pittsburg, U. S. A.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giesserei-Zeitung. *s-m.* Berlin.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Heating and Ventilating Mag. *m.* New York.
Ice and Cold Storage. *m.* London.
Ice and Refrigeration. *m.* New York.
Il Cemento. *s-m.* Milan.
Industrial Engineering. *m.* Pittsburg.
Industrial World. *w.* Pittsburg.
Ingegneria Ferroviaria. *s-m.* Rome.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Int. Marine Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. of Accountancy. *m.* N. Y.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal Franklin Institute. *m.* Philadelphia.
Jour. Ind. & Engng. Chem. *m.* Easton, Pa.
Journal Royal Inst. of Brit. Arch. *s-q.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Jour. Transvaal Inst. of Mech. Engrs., Johannesburg, S. A.
Jour. of U. S. Artillery. *b-m.* Fort Monroe, U. S. A
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Jour. of Worcester Poly. Inst., Worcester, U. S. A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore.
Marine Review. *m.* Cleveland, U. S. A.
Mechanical Engineer. *w.* London.
Mechanical World. *w.* Manchester.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci. Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining World. *w.* Chicago.
Mittheilungen des Vereins für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *w.* New York.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wechensch. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Power and The Engineer. *w.* New York.
Practical Engineer. *w.* London.
Pro. Am. Ins. Electrical Eng. *m.* New York.
Pro. Am. Ins. of Mining Eng. *m.* New York.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Am. Soc. Mech. Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Engrs. Soc. of Western Pennsylvania. *m.* Pittsburg.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Progressive Age. *s-m.* New York.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Age Gazette. *m.* New York.
Railway and Engineering Review. *w.* Chicago.
Railway and Loc. Engng. *m.* New York.
Railway Master Mechanic. *m.* Chicago.
Revista Tech. Ind. *m.* Barcelona.
Revue d'Electrochimie et d'Electrométallurgie. *m.* Paris.
Revue de Mécanique. *m.* Paris.
Revue de Métallurgie. *m.* Paris.
Revue Gén. des Chemins de Fer. *m.* Paris.
Revue Gén. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
School of Mines Quarterly. *q.* New York.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Eng. *m.* Ithaca, N. Y.
Signal Engineer. *m.* Chicago.
Soc. Belge des Elect'ns. *m.* Brussels.
Stahl und Eisen. *w.* Düsseldorf.
Stevens Institute Indicator. *qr.* Hoboken, U. S. A.
Surveyor. *w.* London.
Technik und Wirtschaft. *m.* Berlin.
Technique Moderne. *m.* Paris.
Tramway & Railway World. *m.* London.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Wood Craft. *m.* Cleveland, U. S. A.
Yacht. *w.* Paris.
Zeitschr. f. d. Gesamte Turbinenwesen. *w.* Munich.
Zeitschr. d. Mitteleurop. Motorwagen. Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschr. f. Werkzeugmaschinen. *b-w.* Berlin.